**An analysis of the size and distribution of geographically isolated, small wetlands in the Hudson River estuary watershed**

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August 2009

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Prepared for the Hudson River Estuary Biodiversity Program of the NYS Department of Environmental Conservation's Hudson River Estuary Program.

## Introduction

The objective of this analysis was to estimate the size and distribution of small, *geographically* isolated wetlands within the Hudson River estuary watershed of New York State (NYS). For this analysis, geographic isolation was determined by the distance a wetland occurs from a stream or river body indicating the wetland and water body are not physically or spatially connected. Geographically isolated wetlands were those whose mapped boundaries did not intersect a mapped stream feature (see definition in Tiner 2003). This definition of geographic isolation facilitates a geographic information system (GIS) analysis where information on hydrologic connections between wetlands and streams, lakes, or aquifers is not available. Geographic isolation does not indicate a lack of hydrologic connectivity. **It is important to note that some geographically isolated wetlands could be jurisdictional under federal, state, or local regulatory programs**.

The Hudson River estuary watershed spans the counties bordering the Hudson River from New York City (NYC) to Troy (Figure 1) and harbors exceptional biodiversity within NYS and the northeastern United States. One-half of the NYS population resides within the counties bordering the estuary, which comprise only 13.5% of the land area of the state. Development pressure, climate change, invasive species, and pollution are the primary threats to biodiversity of the estuary watershed. This region of NYS contains a wide variety of wetland types from tidal marshes and swamps to small fens and wet meadows. Wetlands of the watershed are habitat for unique plant and animal communities and are valuable for the ecological services they provide.

Wetland regulatory approaches traditionally have focused on size as a primary criterion. However these criteria may not be adequate to achieve biodiversity conservation, because the species richness of wetlands isn't necessarily influenced by size (Babbitt 2005). Small wetlands perform many of the same ecological functions that larger wetlands provide, including groundwater recharge, flood control, pollutant removal, and wildlife habitat (Tiner et al. 2002). A high percentage of at-risk species are associated with small, isolated wetlands. Wildlife species that are declining in NYS such as the marbled salamander, Jefferson salamander, and spotted turtle, and a number of invertebrate and small mammal species depend on complexes of small wetlands to complete their life cycles (Comer et al. 2005; Tiner 2003). These smaller animals have a limited ability to disperse between wetlands, and the loss of small wetlands can lower wetland densities to the point that wildlife populations are too isolated to survive (Gibbs 2000; Simlitsch & Bodie 2003).

Small and isolated wetlands are particularly vulnerable to loss and degradation within existing state and federal regulatory frameworks. Under provisions of the NYS Freshwater Wetlands Act of 1975 (Article 24 of the Environmental Conservation Law), the Department of Environmental Conservation regulates certain activities affecting wetlands that are 12.4 acres or larger, but only a few smaller wetlands of unusual local importance. For this analysis, we focused on geographically isolated wetlands under 12.4 acres in size in order to capture wetlands potentially most vulnerable to loss or degradation. However, it should be noted again that inclusion in this report does not indicate the actual regulatory status of a wetland.

At the federal level, the Environmental Protection Agency provides oversight and the US Army Corps of Engineers enforces wetlands protections under Section 404 of the 1972 Clean Water Act. Currently, federal regulations most clearly apply to wetlands in close proximity to navigable waters, including major water bodies such as the Hudson River and its larger tributaries. Federal

protections also extend to certain non-navigable waters that are necessary to restore and maintain the "chemical, physical, and biological integrity of the Nation's waters." However, wetlands that are geographically isolated— those surrounded by upland ecosystems and lacking a surface water connection to other water bodies — may not fall into this category. Federal jurisdiction over isolated wetlands is currently decided on a case-by-case basis. Isolated wetlands are thus more vulnerable to regulatory confusion and direct impacts, such as dredging, filling, draining, and dumping, or indirect impacts such as pollution and altered hydrology.

Isolated wetlands in the estuary watershed are typically small depressions that may be found on flats or at the base of gentle slopes. Unique wetland types that can be partially or fully geographically isolated include fens, bogs, sedge meadows, spruce flats, and vernal pools. These wetland types are typically surrounded by terrestrial habitats that include the wetland periphery and terrestrial corridors that biologically connect geographically isolated wetlands (Gibbons 2003). Although small wetlands do occur immediately adjacent to existing larger wetlands, or within the floodplains of tributary streams, a large proportion of small wetlands are expected to be geographically isolated.

## Methods

The study area for this analysis was the Hudson River estuary watershed located in the southeastern portion of NYS (Figure 1). The analysis was completed within four major tributary drainage areas defined by 8-digit Hydrologic Unit Code (HUC-8) boundaries (obtained from the Natural Resource Conservation Service).

The primary source of small wetland data in NYS is the National Wetland Inventory (NWI) carried out by the US Fish & Wildlife Service to generate information about the characteristics, extent, and status of the Nation's wetlands. We used the 1:24,000-scale NWI digital datasets to identify the boundaries of classified wetlands. The recommended minimum mapping unit for 1:24,000-scale imagery is 0.25 to 0.50 acre (Tiner and Smith 1992). The average age of NWI imagery used for maps of the Hudson Valley region is 2001. For the NWI, the Fish & Wildlife Service identified and delineated wetlands from small-scale color infrared aerial photographs based on vegetation, visible hydrology and geography. Due to their scale, NWI wetland maps tend to be used for regional and watershed data display and analysis. They were not designed for use in legal or regulatory programs. The maps do not show all wetlands accurately. Wetlands smaller than the minimum mapping unit and wetland types that are difficult to identify on aerial photography, such as forested or drier emergent wetlands (e.g., wet meadows), are not adequately mapped. However, no other baseline inventory of small wetlands currently exists for the Hudson Valley region.

The NWI data layer contains both polygon and linear water features. To create a base layer for identification of geographically isolated wetland polygons, both lacustrine wetlands (lakes and reservoirs) and linear features (river and stream features) were removed from the NWI data layer, leaving palustrine and riverine wetland polygon features. Palustrine wetlands include freshwater emergent wetlands, freshwater forest/shrub wetlands, and freshwater ponds. Riverine wetlands are associated with a river or stream channel.

Several smaller portions of the estuary watershed lacked NWI wetland data due to incomplete mapping. The lack of NWI wetland data for a small percentage of the study area contributes

error to the analysis, presumably leading to under-estimation of wetland extent. The percent of the study area covered by NWI wetland maps is reported in Table 1.

Table 1. Percent NWI wetland mapping by drainage area.

| | Drainage Area: | | Counties partially or entirely included in drainage area: |
|---|---|---|---|
| 1 | Mid-Hudson River | 93.1 | Albany, Schenectady, Schoharie, Rensselaer, Greene, Columbia, Ulster, Dutchess |
| 2 | Wallkill River | 99.9 | Ulster, Orange, Sullivan |
| 3 | Mid-Southern Hudson River | 100 | Dutchess, Orange, Putnam |
| 4 | Southern Hudson River | 100 | Putnam, Rockland, Westchester |

To develop a layer of geographically isolated wetlands, all NWI wetlands were removed that intersected a 90-m buffer around the Hudson River, and a 35-m buffer around tributary streams. Streams were represented by perennial and intermittent linear features (Flow Type 460) selected from the National Hydrologic Dataset (NHD) flowline layer for NYS. We visually compared alignment of NHD and NWI linear features to digital orthoimagery (2002-2005) and found that in some areas, one or both data layers did not align with visible watercourses (NHD stream data for the Hudson Valley have not yet been aligned with NYS digital orthoimagery). For this reason, NWI linear features were also buffered and the intersecting wetlands extracted. Stream features were buffered to compensate for spatial inaccuracy between mapped stream and wetland features to better capture and remove wetlands that may be intersecting streams. The resulting polygon layer should be a conservative representation of geographically isolated wetlands.

The isolated wetlands were sorted into three size classes to improve understanding of the conservation implications of policy changes. The size classes are: less than 1 acre, 1-3 acres, and 3-12.4 acres. We also examined the extent of wetlands coded with the NWI hydrologic modifier "seasonally flooded" to provide some indication of the percentage of isolated wetlands that could be vernal pools. The NWI most commonly marks vernal pools as "seasonally flooded", although they can also be classified as "intermittently flooded" or "semi-permanently flooded."

Given the incompleteness of NWI coverage within the study area and the under-representation of certain small wetland types on NWI maps, there is a strong likelihood that the extent of small, geographically isolated wetlands in the Hudson Valley is actually greater than what is reported below. Studies in the region have reported inconsistencies between NWI wetland maps and the results of field survey. For example, in a field assessment of reference wetlands in the NYC water supply watershed conducted west of the Hudson River, the majority of surveyed wetlands were larger than as mapped by the NWI, and 8 of the 21 wetlands were not in the NWI at all (NYCDEP 2006). Hudsonia, Ltd. remotely mapped and then ground-truthed wetland locations in eight town study areas in Dutchess County and compared Hudsonia-mapped wetland location and extent with NWI-mapped wetlands. Hudsonia mapped a greater number of wetlands (33-160% more), greater area (8-65% more), and more small (< 0.5 ac) wetlands (49-239% more) than the NWI within study areas (G. Stevens, pers. comm.).

NWI maps tend to err more by excluding wetlands than falsely including wetlands that are not actually there (Tiner 1999). This means that wetlands shown on NWI maps were likely to exist

at the time of mapping. However, users should expect smaller and drier wetlands to be excluded more often in the NWI than larger and more open wetlands.

## Results

Results are reported for each of the four major drainage areas within the estuary watershed: 1) Mid-Hudson River; 2) Mid-Southern Hudson River; 3) Wallkill River; and 4) Southern Hudson River. Results were summarized by drainage area to reflect regional variations in small wetland distribution. Results are also reported for counties of the Hudson River estuary watershed in Appendix I and for all drainage areas overlapping those counties in Appendix II.

Of the total 66,655 non-lacustrine wetlands mapped within the Hudson River estuary watershed, 37,397 or 56% were found to be geographically isolated and "small" (defined as under 12.4 acres in size). The density of small, isolated wetlands ranged from 12 wetlands per square mile in the Mid-Southern Hudson River drainage, to 5 wetlands per square mile in the Southern Hudson River drainage. Table 2 shows the number and density of small, isolated wetlands by drainage area.

The Mid-Hudson River drainage was the largest at 2,228 sq. mi. and contained 40% of all small, geographically isolated non-lacustrine wetlands in the study area (note: NWI wetland maps are 93% complete in the Mid-Hudson River drainage area). The Mid-Southern Hudson River and Wallkill River drainage areas are roughly equivalent in size and contained 31% and 20% of all small, isolated non-lacustrine wetlands respectively.

The total area of non-lacustrine wetlands mapped in the NWI for the study area is 243,460 acres, of which 36,942 acres or 15% are small and geographically isolated. Of these, 26% were less than 1 acre, 29% between 1-3 acres, and 45% between 3-12.4 acres. Table 3 shows the total acreage of isolated wetlands and size distribution by drainage area. Within the study area, 93% of the total acreage of small, isolated non-lacustrine wetlands occurred on private lands.

NWI mapped seasonally flooded wetlands were 70% of all small, isolated non-lacustrine wetland acres in the study area. They accounted for 72% of all isolated non-lacustrine wetland acres in the Wallkill River drainage and 73% in the Mid-Southern Hudson River drainage.

## Discussion

The goal of this GIS analysis was to estimate the size and distribution of geographically isolated wetlands that fall beneath the 12.4-acre NYS regulatory threshold in the Hudson River estuary watershed.

We worked with geographic isolation to address wetlands that are potentially vulnerable to legal confusion and direct impacts. Geographic isolation does not indicate a lack of importance for these wetlands. Small, geographically isolated wetlands perform valuable ecological and biological functions that are unique or similar to larger wetlands. Although geographic isolation suggests, but does not confirm, a lack of surface-water connection to other water bodies, isolated wetlands may still be hydrologically connected to other water bodies through groundwater flows or infrequent flood events. Some isolated wetlands form where groundwater discharges to the surface, yet are not covered by federal policy because of their distance from navigable waters (Bedford and Godwin 2003). Wetlands may also be ecologically connected for many organisms. For example, seasonally flooded vernal pools (relatively permanent ephemeral wetlands that dry up during the summer months) are highly connected to surrounding terrestrial habitats and by habitat corridors between wetlands (Zedler 2003).

In the Hudson estuary watershed, 56% of all non-lacustrine wetlands and 15% of all non-lacustrine wetland acres were geographically isolated and smaller than the key state regulatory threshold of 12.4 acres in size. As noted above, the number of small, isolated wetlands is probably under-estimated in this analysis, as some forested, ephemeral, and drier wetlands do not appear on NWI maps. This suggests much of the region's unique wetland habitat is vulnerable to loss until federal, state, or local governments and individual landowners take additional action.

This analysis indicates that small, geographically isolated wetlands occur at fairly high densities and numbers throughout the Hudson River estuary watershed. We were not able to evaluate the quality and value of these wetlands. However, wetland density in general is an important factor for the survival of wetland species. Average maximum dispersal distances for wetland-dependent frogs, salamanders, and small mammals are about 984 ft (0.2 mi) (Semlitsch and Bodie 2003; Gibbs 2000), while some reptiles have longer dispersal distances. Gibbs (2000) found that urban landscapes of the NYC metropolitan area with less than 2.5 wetlands/$mi^2$ were unsuitable for wetland wildlife populations, compared to a relatively undisturbed Maine landscape with an average 5.6 wetlands/$mi^2$. Average wetland densities within Hudson estuary drainages ranged from 5 to 12 wetlands per square mile. These results suggest that significant opportunities remain to conserve the unique wildlife populations found within the Hudson estuary region.

Although all drainage areas had significant small wetland resources, the Mid-Southern Hudson River drainage had the highest density of small, isolated wetlands and the second highest number of small, isolated wetlands when compared to other drainage areas. It contains the watersheds of the Wappingers Creek, Fishkill Creek, Moodna Creek, and Black Creek tributaries to the Hudson River. This region of the Hudson Valley has been previously recognized for its exceptional biodiversity found within ecological areas that contain exceptional types and numbers of wetlands (Penhollow et al. 2006), and harbors wetland species of state and national significance. The high density and range of small wetland sizes found in the Mid-Southern Hudson River drainage contribute to its conservation priority.

The Hudson Valley is estimated to have 6% wetland cover, an extent that is comparable to the state average of 7% wetland cover. However, in the estuary watershed, there is a higher proportion of smaller wetlands when compared to other regions of the state (Huffman and Associates 1999). The same is true when the comparison is made to national averages. The Hudson Valley has a higher percentage of wetlands – 56% that are small and geographically isolated — compared to preliminary U.S. estimates of 20% to 30% of wetlands considered isolated and potentially vulnerable to direct impacts (Cappiella and Fraley-McNeal 2007).

**Table 2.** Number and density of NWI-mapped small, isolated non-lacustrine wetlands by drainage area.

| | Drainage Area | NWI Coverage within Drainage Area (sq.mi) | Total # Non-Lacustrine Wetlands | # Small, Isolated Wetlands | Small, Isolated Wetland Density (#/sq.mi.) | % Small, Isolated Wetlands |
|---|---|---|---|---|---|---|
| 1 | Mid-Hudson River | 2228 | 26,945 | 15000 | 7 | 56 |
| 2 | Wallkill River | 977 | 12,320 | 7580 | 8 | 62 |
| 3 | Mid-Southern Hudson River | 943 | 19,437 | 11709 | 12 | 60 |
| 4 | Southern Hudson River | 666 | 7953 | 3108 | 5 | 39 |
| | **Entire Study Area:** | 4814 | 66,655 | 37397 | 8 | 56 |

**Table 3.** Area and percent of NWI mapped small, isolated non-lacustrine wetlands by drainage area.

| | Drainage Area | Total Non-Lacustrine NWI Wetland Acreage | Small, Isolated Wetland Acreage | % Area Small, Isolated Wetland | < 1 acre Acreage | % < 1 Acre | 1-3 acre Acreage | % 1-3 Acres | 3-12.4 Acreage | % 3-12.4 Acres |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Mid-Hudson River | 90246 | 15333 | 17 | 3597 | 23 | 4662 | 30 | 7074 | 46 |
| 2 | Wallkill River | 43670 | 9681 | 22 | 1985 | 21 | 2677 | 28 | 5019 | 52 |
| 3 | Mid-Southern Hudson River | 59371 | 9338 | 16 | 3071 | 33 | 2709 | 29 | 3559 | 38 |
| 4 | Southern Hudson River | 50173 | 2590 | 5 | 827 | 32 | 761 | 29 | 1002 | 39 |
| | **Entire Study Area:** | 243460 | 36942 | 15 | 9840 | 26 | 10809 | 29 | 16654 | 45 |

This analysis also found that 70% of small, isolated non-lacustrine wetlands in the estuary region are seasonally flooded wetlands. Surface water is present in seasonally flooded wetlands for extended periods in the growing season, but absent by the end of the growing season in most years. This class of wetland type often includes vernal pools, which are associated with unique wildlife populations and support high amphibian diversity in the estuary watershed. Vernal pools are small, shallow wetlands that usually occur in forests and tend to be over-looked and under-valued due to their ephemeral hydrology and small size. The high percentage of vernal pools in the estuary watershed, and relative lack of protection, reinforces the need for conservation efforts specifically focused on this wetland type.

The Hudson Valley is undergoing rapid development, and small wetlands are still being lost (Huffman and Associates 1999). In addition to being small and geographically isolated, the vast majority of these wetlands tend to occur on private lands. Thus, their continued existence and ecological health requires private land stewardship in concert with local conservation plans and policies. Given the vulnerable nature of small, geographically isolated wetlands, and our relative lack of knowledge of their extent, location and particular ecological values, these wetlands should be given a high priority in public and private conservation initiatives. Targeted inventory and conservation programs are required to identify and conserve remaining high-value small wetlands if we are to maintain the water quality and habitat functions that support the Hudson River estuary and unique natural setting of the region.

***Acknowledgements***
This project was funded by the New York State Environmental Protection Fund through the Hudson River Estuary Program of the New York State Department of Environmental Conservation (NYSDEC). The NYSDEC Division of Fish, Wildlife and Marine Resources provided access to GIS data layers, software, and facilities necessary for completion of the analysis. The authors would like to thank the following for their review and contributions to this report: Laura Heady, Cornell University; Clare Dunn, NEIWPCC; and J.R. Jacobson and Tim Post, NYSDEC. Our thanks to Laurie Machung, NYC Department of Environmental Protection and Gretchen Stevens, Hudsonia, Ltd. for providing information used in the report.

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**Appendix I.** Statistics on the size and distribution of geographically isolated wetlands in counties of the Hudson Valley.

**Table 1.** Area and percentage of NWI mapped small, isolated non-lacustrine wetlands by county.

| County Name | % NWI Coverage | Total NWI Non-Lacustrine Wetland Acreage | Small, Isolated Wetland Acreage | % Area Small, Isolated Wetland | < 1 acre Acreage | % < 1 Acre | 1-3 acre Acreage | % 1-3 Acres | 3-12.4 acre Acreage | % 3-12.4 Acres | Seasonally Flooded Wetlands < 12.4 acres Acreage | Small, Isolated Wetlands on Private Land Acreage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Albany | 95.4 | 14147 | 3225 | 23 | 688 | 21 | 995 | 31 | 1542 | 48 | 1890 | 3013 |
| Columbia | 100 | 33676 | 5916 | 18 | 1331 | 23 | 1749 | 30 | 2835 | 48 | 4223 | 5813 |
| Dutchess | 100 | 48711 | 8768 | 18 | 2682 | 31 | 2692 | 31 | 3394 | 39 | 6543 | 8395 |
| Greene | 86.9 | 12977 | 1312 | 10 | 496 | 38 | 426 | 32 | 390 | 30 | 558 | 1237 |
| Orange | 99.9 | 44492 | 8149 | 18 | 2061 | 25 | 2280 | 28 | 3809 | 47 | 6022 | 7168 |
| Putnam | 100 | 11050 | 1212 | 11 | 365 | 30 | 346 | 29 | 501 | 41 | 911 | 881 |
| Rensselaer | 100 | 24743 | 5737 | 23 | 1162 | 20 | 1767 | 31 | 2808 | 49 | 3948 | 5529 |
| Rockland | 100 | 18291 | 931 | 5 | 268 | 29 | 321 | 34 | 342 | 37 | 609 | 532 |
| Ulster | 100 | 41219 | 7835 | 19 | 1671 | 21 | 2188 | 28 | 3976 | 51 | 5475 | 7436 |
| Westchester | 100 | 28271 | 1737 | 6 | 682 | 39 | 535 | 31 | 520 | 30 | 966 | 1397 |
| **Entire County Area:** | | 277577 | 44822 | 16 | 11406 | 25 | 13299 | 30 | 20117 | 45 | 31145 | 41401 |

**Table 2.** Percent of NWI mapped small, isolated wetland acres within the 10-county area.

| | % of Small, Isolated Wetland Acres | % of All NWI Non-Lacustrine Wetland Acres |
|---|---|---|
| Small, Isolated Wetlands | 100 | 16 |
| Small, Isolated Wetlands < 1 acre | 25 | 4 |
| Small, Isolated Wetlands 1-3 acres | 30 | 5 |
| Small, Isolated wetlands 3-12.4 acres | 45 | 7 |
| Seasonally Flooded Wetland < 12.4 acres | 70 | 11 |
| Isolated Wetlands on Private Land | 92 | 15 |

**Table 3.** Number and density of NWI mapped small, isolated wetlands by county.

| County Name | NWI Coverage within County (sq.mi) | Total # NWI Non-Lacustrine Wetlands | # Small, Isolated Wetlands | Small, Isolated Wetland Density (#/sq.mi.) | % Small, Wetlands Isolated |
|---|---|---|---|---|---|
| Albany | 508 | 4853 | 2966 | 6 | 61 |
| Columbia | 648 | 10700 | 5881 | 9 | 55 |
| Dutchess | 824 | 18920 | 10907 | 13 | 58 |
| Greene | 571 | 3967 | 1884 | 3 | 47 |
| Orange | 837 | 12900 | 7474 | 9 | 58 |
| Putnam | 246 | 3135 | 1319 | 5 | 42 |
| Rensselaer | 665 | 8366 | 4701 | 7 | 56 |
| Rockland | 199 | 2388 | 1020 | 5 | 43 |
| Ulster | 1160 | 10500 | 6410 | 6 | 61 |
| Westchester | 475 | 5654 | 2488 | 5 | 44 |
| **Entire Study Area:** | 6135 | 81383 | 45050 | 7 | 55 |

**Appendix II.** Statistics on the size and distribution of geographically isolated wetlands within all HUC-8 drainage areas intersecting the 10 counties bordering the Hudson River estuary north of NYC.

**Table 1.** Area and percentage of NWI mapped small, isolated non-lacustrine wetlands within drainage areas.

| Drainage Area | % NWI Cover | Total NWI Non-Lacustrine Wetland Acreage | Small, Isolated Wetland Acreage | % Area Small, Isolated Wetland | < 1 acre Acreage | % < 1 Acre | 1-3 acre Acreage | % 1-3 Acres | 3-12.4 acre Acreage | % 3-12.4 Acres | Seasonally Flooded Wetlands < 12.4 acres Acreage | Small, Isolated Wetlands on Private Land Acreage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Southern Hudson River | 100 | 50173 | 2590 | 5 | 827 | 32 | 761 | 29 | 1002 | 39 | 1739 | 1873 |
| Upper Hackensack River | 100 | 5957 | 1276 | 21 | 370 | 29 | 383 | 30 | 523 | 41 | 951 | 690 |
| Mid-Southern Hudson River | 100 | 59371 | 9338 | 16 | 3071 | 33 | 2709 | 29 | 3559 | 38 | 6866 | 8654 |
| Still River | 100 | 10403 | 2612 | 25 | 531 | 20 | 897 | 34 | 1184 | 45 | 1970 | 2470 |
| Mid-Delaware River | 54 | 8610 | 1550 | 18 | 255 | 16 | 374 | 24 | 921 | 59 | 1048 | 1491 |
| East Branch Delaware River | 77 | 4394 | 593 | 13 | 276 | 47 | 166 | 28 | 151 | 25 | 239 | 478 |
| Mid-Hudson River | 93 | 90246 | 15333 | 17 | 3597 | 23 | 4662 | 30 | 7074 | 46 | 10328 | 14688 |
| Schoharie Creek | 63 | 10174 | 1907 | 19 | 472 | 25 | 502 | 26 | 933 | 49 | 720 | 1716 |
| Mid-Northern Hudson River | 100 | 61446 | 11058 | 18 | 2011 | 18 | 3287 | 30 | 5760 | 52 | 6992 | 10809 |
| Mohawk River | 46 | 50844 | 11718 | 23 | 1418 | 12 | 3317 | 28 | 6983 | 60 | 8750 | 8738 |
| Wallkill River | 100 | 43670 | 9681 | 22 | 1985 | 20 | 2677 | 28 | 5019 | 52 | 6962 | 9225 |
| Bronx River | 100 | 2198 | 505 | 23 | 174 | 34 | 168 | 33 | 163 | 32 | 171 | 301 |
| Lower Byram River | 100 | 2147 | 326 | 15 | 135 | 41 | 87 | 27 | 104 | 32 | 198 | 322 |
| **Entire Drainage Area:** | | 399633 | 68487 | 17 | 15122 | 22 | 19990 | 29 | 33376 | 49 | 46934 | 61455 |

**Table 2.** Number and density of NWI mapped small, isolated wetlands by drainage area.

| Drainage Area | NWI Coverage within Drainage Area (sq.mi) | Total # NWI Non-Lacustrine Wetlands | # Small, Isolated Wetlands | Small, Isolated Wetland Density (#/sq.mi.) | % Wetlands Small, Isolated |
|---|---|---|---|---|---|
| Southern Hudson River | 666 | 7953 | 3108 | 5 | 39 |
| Upper Hackensack River | 211 | 2858 | 1374 | 7 | 48 |
| Mid-Southern Hudson River | 943 | 19437 | 11709 | 12 | 60 |
| Still River | 219 | 4414 | 2401 | 11 | 54 |
| Mid-Delaware River | 351 | 2343 | 1010 | 3 | 43 |
| East Branch Delaware River | 644 | 3044 | 1188 | 2 | 39 |
| Mid-Hudson River | 2228 | 26945 | 15000 | 7 | 56 |
| Schoharie Creek | 580 | 4341 | 1952 | 3 | 45 |
| Mid-Northern Hudson River | 1282 | 16682 | 8448 | 7 | 51 |
| Mohawk River | 1157 | 12579 | 6524 | 6 | 52 |
| Wallkill River | 977 | 12320 | 7580 | 8 | 62 |
| Bronx River | 139 | 1519 | 620 | 4 | 41 |
| Lower Byram River | 46 | 1116 | 523 | 11 | 47 |
| **Entire Drainage Area:** | 9443 | 115551 | 61437 | 7 | 53 |