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RESEARCH, RESTORATION, EDUCATION

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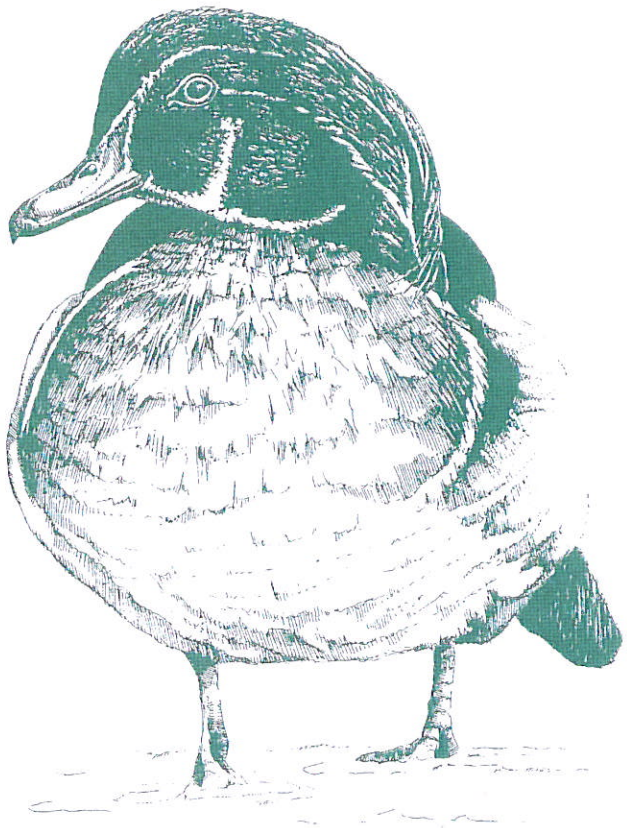


Wood Duck
Aix sponsa

An excellent aviator through densely wooded swamps, rivers, and creeks, the small (17"-20") Wood Duck can be recognized by its distinctive "whistling" in flight and by its beautiful breeding plumage. The male Wood Duck displays bold iridescent purples, blues, greens, and white; has a conspicuous crest, and a red bill. The female, though dull in color and mostly gray, has a distinctive eye ring.

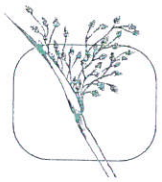
Nesting in tree cavities (usually over the water), this species was threatened by development and forestry practices until successful efforts were made to provide readily accepted nest boxes. Clutches may be from 15-50 young, resulting from 2-10 females "dumping" their eggs into another female's nest. The young spend their first 24 hours in the nest. Equipped with claws, they will climb (up to 8') out of the nest and fall directly into the water.

The Wood Duck feeds on seeds, acorns, berries, grain, and aquatic and terrestrial insects and other invertebrates.

This species breeds from Nova Scotia and south central Canada, south to Florida and the Gulf Coast, west to Texas. Winters from North Carolina south to Cuba and Bahamas; also on the west coast, north to Washington.

A Comparison of Wetland Areas in Northern Virginia: National Wetland Inventory Maps *Versus* Field Delineated Wetlands Under the 1987 Manual

--Michael S. Rolband



The experience of delineating hundreds of sites in Northern Virginia has provided a basis to observe that National Wetland Inventory (NWI) maps typically understate actual wetland areas in this geographic area. Critics of this statement have noted that this anecdotal observation was based primarily upon sites that were relatively small, five acres (2 hectares) to three hundred acres (121 hectares). It was argued that only sites greater than +300 acres (121 hectares) could be used to substantiate such an analysis, so as to ensure that the selected sites were not simply the result of "cherry-picking out" drier land parcels on the ridges of watershed divides. Thus, this article reports on an analysis of five (5) sites, totaling five thousand eight hundred twelve (5,812) acres (2,352 hectares) in Northern Virginia; the smallest site is +400 acres (162 hectares). Four hundred fifty-eight (458) acres (185 hectares) of Jurisdictional Wetlands and Waters of the U.S. were delineated on these sites utilizing the "Corps of Engineers Wetland Delineation Manual" (Environmental Laboratory 1987), compared to one hundred fifty-five (155) acres (63 hectares) estimated by NWI maps.

This analysis supports the hypothesis that NWI maps understate actual wetland areas. Tiner, et. al. (1994, 1986) provides data to support extrapolation of this hypothesis across the Chesapeake Bay watershed. This conclusion is significant because the extent of wetlands within the landscape can have dramatic economic impacts. Furthermore, significant federal, state, and local government regulatory programs and policies are being based upon NWI maps. Finally, significant government funding is being disbursed to digitize these existing mapping resources, implying a level of accuracy that is simply not present.

BACKGROUND

Several circumstances over the past three years have demanded that the accuracy of NWI maps be examined and discussed:

1. Financial institutions have loaned land acquisition funds with reliance upon statements that "no Jurisdictional Wetlands exist" based upon review of the applicable NWI map(s).
2. Hundreds of thousands of dollars are being expended to digitize the NWI maps - implying a level of accuracy that is misleading - for the purpose of providing wetland managers the ability to manage this natural resource utilizing Geographic Information Systems.
3. Land-use regulatory programs, such as Virginia's Chesapeake Bay Act, have caused localities to create maps of Resource Protection Areas (RPAs), where most land disturbing activities are prohibited, based primarily upon NWI maps and USGS (U.S. Geological Survey) maps. While the use of NWI and USGS maps (which are the base for NWI maps) are not mandated, the Chesapeake Bay Local Assistance Department recommends their use as a starting point. Often, since no other resources are available, it becomes the primary basis of RPAs. Although field truthing is mandated, some localities will not change the map, and if the field truth is not what interested parties desire, the resulting outcry is often not productive.

   The Chesapeake Bay Act defines one RPA core component, the tributary stream, to be a solid blue line on a USGS quadrangle map. The USGS (Anderson 1993) states "We suggest that if quadrangles are used, they be considered only an initial indicator of prospective RPAs." More interesting are comments by Leopold (1994, pg. 228) regarding USGS maps: "... the headwater limits of the blue lines do not reflect any statistical characteristic of stream flow occurrence.... The blue lines on a map are drawn by nonprofessional, low-salaried personnel ... drawn to fit a rather personalized aesthetic...."

   NWI maps are used to estimate wetlands that are RPA components. However, these maps do not differentiate between wetlands that meet the criteria of an RPA and those that do not. And, as discussed herein, many wetlands are not shown on the NWI maps. Thus, the resulting maps both under and over estimate the extent of RPAs compared to maps resulting from field data.
4. Land developers, land-use regulators, and environmental consultants are relying upon NWI maps to determine if a wetland delineation should be considered during feasibility periods, based upon a decision tree that assumes that a delineation is only needed to precisely determine the wetland boundary if the NWI maps indicate that wetlands are present on the site.

Blue Flag
Iris versicolor

Fresh to moderately brackish tidal marshes, swamps, wet meadows and shores.

Newfoundland to Manitoba, south to Virginia and Minnesota.

It was observed that NWI maps typically understate the areal extent of Jurisdictional Wetlands and Waters of the U.S.[1] in Northern Virginia, and that these areas are predominantly forested wetlands and wet meadows associated with small drainage areas and low order waterways. Observation also indicates that whenever wetlands are shown on NWI maps, they are in fact, found in the field.

Although the NWI map indicates wetlands in a certain area, the relationship between the size of the actual wetlands and the NWI Map graphics is not always consistent. For example, the same line weight with a PF01A designation can describe a 3-5' wide intermittent stream in a hedgerow, or a 100' wide palustrine forest around a perennial stream. These anecdotal observations were made to a group of regulatory personnel and private consultants during a wetland ecology course in July of 1993. The resulting discussion was that the majority of the regulatory personnel present felt that these observations were incorrect because:

1. The "typical" delineation projects undertaken by the consultants were too small to be a valid sampling - at least 200-300 (81-121 ha) contiguous acres would need to be sampled to ensure that the selected sites were simply not just "cherry-picking" out drier ridgelines for development.
2. U.S. Fish & Wildlife Service (USFWS) personnel sample the wetland areas identified on NWI maps to verify their accuracy. However, this testing method does not address the issue regarding the status of areas not mapped as wetlands.

METHODOLOGY

The hypothesis was tested against five sites [the smallest of which is +400 acres (162 hectares)] located in Northern Virginia (Prince William County and Loudoun County), totaling 5,812 acres (2,352 hectares), which were delineated between August 1993, and October 1994, for several private companies by Wetland Studies and Solutions, Inc. (WSSI). Each delineation, performed utilizing the 1987 Manual methodology (Environmental Laboratory 1987), has been reviewed and approved by the U.S. Army Corps of Engineers (ACOE) and thus, is a matter of public record; all boundary flags have been located by conventional survey techniques by licensed land surveyors.

Table 1. Delineated wetlands vs. NWI wetlands

COE Jurisdictional Determination Number	Location (County)	Total Site Area ac/(ha)	Delineated Wetlands Area ac/(ha)	NWI Wetlands Area ac/(ha)	Delineated Wetlands/ NWI Wetlands Area Ratio
94-6014	Prince William	3,006 (1,217)	288.26 (117)	84 (34)	3.43
94-6034	Prince William	410 (166)	15.10 (6)	10 (4)	1.51
94-6529	Loudoun	1,510 (611)	79.79 (32)	14 (6)	5.70
94-6545	Prince William	486 (197)	41.16 (17)	37 (15)	1.11
94-6594	Prince William	400 (162)	33.29 (13)	10 (4)	3.33
TOTAL		5,812 (2,352)	458 (185)	155 (63)	2.95

metric conversion: 1 acre = 0.405 hectares

RESULTS

Comparison to NWI

Table 1 provides a comparison between the actual area of Jurisdictional Wetlands versus the area of wetlands identified by the NWI. In aggregate, actual Jurisdictional Wetlands total 458 acres (185 hectares), an amount almost three (3) times greater than the 155 acres (63 hectares) depicted on NWI maps.

Table 2 provides the delineated upland/wetland boundary versus the NWI upland/wetland boundary, and a ratio of these lengths to their respective areas. This boundary area ratio is an indication of the regularity of the areas being described. The actual wetland area to boundary ratio is 1.9 times larger than the NWI ratio. The actual delineated upland/wetland boundary is 5.6 times greater than NWI upland/wetland boundaries. These ratios are numeric indicators of the numerous small, but cumulatively significant, wetland areas that branch off of the areas typically covered in the NWI maps.

Comparison to Hydric Soil Maps

Another significant component of background data collection prior to performing a wetland delineation, is a review of the Soil Conservation Service (SCS; now the National Resource Conservation Service) soil survey for each site. Anecdotal observations have indicated that these maps often provide a good suggestion of the pattern of wetlands across a landscape, and that the SCS soil maps using hydric soils as a wetland indicator, overstate the actual extent of wetlands - a logical result, since soils are only one component of the 1987 Manual delineation methodology, and because of land-use changes (i.e., agriculture, stream erosion, etc.) that have drained many hydric soil areas. The data presented in Table 3 support these observations. Since the NWI maps understate the actual wetland area, and the mapped hydric soils overstate the area of wetlands, an attempt was made to develop a statistically valid correlation between both mapping sources and actual field conditions. However, a reasonably valid relationship could not be developed with the available information.

Continued next page.

1. In this article, a Jurisdictional Wetland is one that is delineated as a wetland pursuant to the methodology described in the "Corps of Engineers Wetlands Delineation Manual", Technical Report Y-87-1 (Environmental Laboratory 1987); and a Water of the U.S. (WOUS) includes wetlands, streams, rivers, ponds, lakes, and other deep water habitat as defined at 33CFR328.3 (a). For the remainder of this article, Jurisdictional Wetlands and Waters of the U.S. will be referred to as wetlands.

NWI MAPS

Continued from previous page.

Table 2. Upland/wetland boundry comparison

COE Jurisdictional Determination Number	Total Site Area ac/(ha)	Delineated Wetlands Area ac/(ha)	Delineated Upland-Wetlands Boundry lf/(m)	NWI Wetlands Area ac/(ha)	NWI Upland-Wetlands Boundry lf/(m)	Delineated Boundry/Area Ratio lf/ac/(m/ha)	NWI Boundry/Area Ratio lf/ac/(m/ha)	Delineated/NWI Ratio Factor
94-6014	3,006 (1,217)	288.26 (117)	484,207 (147,586)	84 (34)	102,000 (31,090)	1,680 (1,265)	1,214 (915)	1.38
94-6034	410 (166)	15.10 (6)	43,395 (13,227)	10 (4)	14,300 (4,359)	2,874 (2,164)	1,430 (1,077)	2.01
94-6529	1,510 (611)	79.79 (32)	219,238 (66,824)	14 (6)	10,000 (3,048)	2,748 (2,069)	714 (538)	3.85
94-6545	486 (197)	41.16 (17)	76,832 (23,418)	37 (15)	27,000 (8,230)	1,867 (1,406)	730 (550)	2.56
94-6594	400 (162)	33.29 (13)	73,167 (22,301)	10 (4)	8,100 (2,469)	2,198 (1,655)	810 (610)	2.71
TOTAL	5,812 (2,352)	458 (185)	896,839 (273,357)	155 (63)	161,400 (49,195)	1,960 (1,476)	1,041 (784)	1.88

metric conversion: 1 acre = 0.405 hectares
1 linear foot = 0.3048 meters

VALIDITY OF RESULTS

It is not suggested that the sampling provided, though it represents a significant effort, is large enough to conclusively indicate that the NWI maps are incorrect by a specified percentage. However, currently available NWI maps significantly understate the areal of extent of wetlands in Northern Virginia.

Tiner, et. al. (1994) provides significant evidence that this conclusion may also be applicable to larger areas, such as the Chesapeake Bay's 64,000 square mile (165,895 km2) watershed. Tiner, et. al. (1994) states:

"Existing National Wetlands Inventory (NWI) maps derived from color infrared aerial photos were used as the basis to record the current location of wetlands, with improvements made through examination of aerial photos. When these maps were not available (e.g., maps based on black and white photographs), recent color infrared aerial photography (i.e., 1:58,000 or 1:40,000) was interpreted. Improvements or enhancements based on re-examination of the original NWI photointerpretation were added to the wetland status overlay prior to performing trends analysis. *This means that more wetland acreage was present in 1982 than the former study by Tiner and Finn (1986) had estimated."*

In fact, Tiner, et. al. (1994) estimates that 34.8% more palustrine wetlands (the classification of wetlands delineated on the subject sites) existed in 1982 in the Chesapeake Bay watershed, than Tiner and Finn (1986) estimated with NWI maps. Tiner, et. al. (1994) estimates that there were 1,353,644 acres 548,226 hectares) of palustrine wetlands in 1982; while Tiner and Finn (1986) estimates that there were 1,003,945 acres (406,598 hectares) of palustrine wetlands.

Table 3. Delineated wetlands vs. mapped hydric soils

COE Jurisdictional Determination Number	Total Site Area ac/(ha)	Delineated Wetlands Area ac/(ha)	Mapped Hydric Soils Area ac/(ha)	Mapped Soils w/ Hydric Inclusions Area ac/(ha)	Delineated Wetlands /Mapped Soils Area Ratio
94-6014	3,006 (1,217)	288.26 (117)	457 (185)	1,530 (619)	0.631
94-6034	410 (166)	15.10 (6)	24 (10)	388 (157)	0.629
94-6529	1,510 (611)	79.79 (32)	583 (236)	158 (64)	0.137
94-6545	486 (197)	41.16 (17)	24 (10)	53 (21)	1.715
94-6594	400 (162)	33.29 (13)	75 (30)	171 (69)	0.444
TOTAL	5,812 (2,352)	458 (185)	1,163 (471)	2,300 (931)	0.393

metric conversion: 1 acre =0.405 hectares

The previous quote from Tiner, et. al. (1994) suggests a possible rationale for the inaccuracy: the type of photography utilized to create the specific NWI map. Each NWI map provides the date, photography type (B/W - black and white; CIR - color infrared) and scale. Table 4 provides the wetland data versus the photography type. It shows results that are counter-intuitive, conclusively removing this rationale from consideration. With respect to the sites used for this study, the most accurate NWI maps are those prepared with black and white film at 1:80,000 scale; while the maps using color infrared film at 1:58,000 scale, yield less accurate results.

EFFECT OF USING THE 1987 MANUAL

The NWI maps utilize the USFWS wetland definition published in its official wetland classification system (Cowardin, et. al. 1979). Tiner, et. al. (1994) notes that this definition is consistent with the Federal Manual for Identifying and Delineating Wetlands (Federal Interagency Committee for Wetland Delineation 1989), and suggests that the extent of wetland areas identified by the 1987

Table 4. Wetland mapping vs. NWI photography source

COE Jurisdictional Determination Number	Location (County)	Total Site Area ac/(ha)	Delineated Wetlands Area ac/(ha)	NWI Wetlands Area ac/(ha)	Delineated Wetlands/ NWI Wetlands Area Ratio	USGS Quad	NWI Photo Date	NWI Photo Type	NWI Photo Scale
94-6014	Prince William	3,006 (1,217)	288.26 (117)	84 (34)	3.43	Thoroughfare Gap, VA	3/77	B/W	1:80000
94-6034	Prince William	410 (166)	15.10 (6)	10 (4)	1.51	Gainesville, VA	3/77	B/W	1:80000
94-6529	Loudoun	1,510 (611)	79.79 (32)	14 (6)	5.70	Sterling, VA & Leesburg,VA (1)	3/80 3/80	CIR CIR	1:58000 1:58000
94-6545	Prince William	486 (197)	41.16 (17)	37 (15)	1.11	Quantico,VA	3/77	B/W	1:80000
94-6594	Prince William	400 (162)	33.29 (13)	10 (4)	3.33	Gainesville, VA	3/77	B/W	1:80000
TOTAL		5,812 (2,352)	458 (185)	155 (63)	2.95				

(1) This site was on two USGS Quads

metric conversion: 1 acre = 0.405 hectares

Manual will be less than those areas classified under the USFWS method. Thus, it is likely that the use of a wetland delineation method more consistent with the USFWS methodology (i.e., the 1989 Manual) would exacerbate the discrepancies encountered with the NWI maps on the subject sites discussed in this study.

WETLAND LOSSES ARE NOT BEING CHALLENGED

It is critical to note that this discussion should not be utilized to challenge wetland loss trends (e.g. Tiner, et. al. 1994) that are based upon a photographic analysis of specific locations at the beginning and end of a specified time period. Those losses are clearly documented.

However, any loss estimate based upon a comparison of historically existing wetlands versus the wetland area determined by NWI mapping is clearly suspect.

Obviously, there are enough numbers to support anyone's position:

1. In July, 1994, the 1992 National Resources Inventory (SCS 1994) indicated 140,000 acres (56,700 hectares) of wetlands were lost per year from 1982 to 1992.
2. In October, 1994, a Chesapeake Bay Program publication (Eckles 1994) noted in its preface, a loss rate of over 300,000 acres (121,500) per annum from the late 1950's to the late 1970's, without mentioning the recently published SCS report.
3. In October, 1994, *Builder Magazine* (German 1994) reported a possible net gain in wetland resources based upon the SCS report noted above and several USFWS and USDA programs.

What is still needed is accurate data that documents the results of significant regulatory changes since early 1992. This data could be more useful to policy makers than the integration of imprecise NWI maps into a Geographic Information System.

CONCLUSIONS

From the comparison between the areal extent of wetlands provided herein, it is evident that NWI maps significantly underestimate the area of wetlands. A survey of 5,812 acres (2,352 hectares) in Loudoun and Prince William Counties, Virginia, indicated that actual wetland areas were almost three times greater than the areas depicted by National Wetland Inventory maps. The understated areas of wetlands seem to be located primarily in small forested watersheds that do not have USGS mapped streams. This conclusion has several significant ramifications for wetland policy makers, land-use policy makers, land-owners, and taxpayers:

1. Estimates of wetland areas based upon the National Wetland Inventory are clearly erroneous.
2. Landowners and land-use planners cannot rely upon data in the National Wetland Inventory to make land acquisition or land-use decisions. The level of accuracy of this resource is clearly inadequate when considering the massive land valuation impacts from land-use policies based upon the presence of wetlands (such as the Clean Water Act and Virginia's Chesapeake Bay Act's Resource Protection Area).
3. U.S. Government funding is currently being expended to convert NWI maps to a digital format for use by Geographic Information Systems, implying a level of accuracy that is clearly inappropriate, and enhancing the probability that this data will be relied upon for regulatory decisions and actions without an understanding of its limited level of accuracy. This program will not be able to assist wetland managers in assessing the effect of the significant regulatory changes that have occurred since early 1992.
4. The use of NWI and USGS mapping resources as the basis of a regulatory program is problematic when regulators and legislators are not fully

Continued next page.

NWI MAPS

Continued from previous page.

informed of the limitations of these resources. Some regulations would probably be revised if these limitations were known by such decision makers. ❀

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ID BOUNDRIES

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8. Be aware of seasonal limitations when agreeing to do a wetland delineation in an unfamiliar geographic region. Although wetland delineations can usually be performed year-round in southern states, they can be procedurally impossible in cold regions when there is a snowpack or extended periods of frozen surface soils. Learn what the seasonally wet and seasonally dry periods are for the region of your delineation, and learn the extent of the growing season.

9. When working in an unfamiliar geographic region, be suspicious of areas that display strong evidence of one or two of the three wetland delineation parameters, but weak or no evidence of the other(s). For example, proceed cautiously if an area of undrained hydric soils appears to lack hydrophytic vegetation. Make sure that the dominant plant species are properly identified. Look more closely for remains of tender herbaceous plants whose tops are alive only during specific seasons. I have encountered some forested wetlands in eastern states that appear to be dominated exclusively by Red Maple (FAC[1]) from late fall through early spring, but which support dense groundcover of FACW[1] and OBL[1] fern species during the summer.

In conclusion, wetland delineators must recognize that different geographical regions present unique delineation challenges. They must prepare to perform a delineation in a new region by speaking with local authorities and learning about regionally frequent plant species, soil series, and hydrological conditions. Above all, wetland delineators must be willing to apply logic and professional judgment to their delineations and avoid approaching delineations, especially delineations in unfamiliar geographic regions, as a mechanical procedure. ❀

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