Technical Report:

Wetland Mapping Evaluation and Review of Wetland Attributes in the North East Drift Plains of North Dakota.

U.S. Fish & Wildlife Service, Devils Lake Wetland Management District
And
Ducks Unlimited Inc.

Author: Scott Ralston
January 2008

Abstract

Success in delineating wetland basins in the Northeast Drift Plains (NEDP) of North Dakota may be improved by using multiple sources of aerial imagery as well as other GIS tools. Two other wetland inventories were compared in which both were found to miss over 25% of wetland basins identified in this study using multiple mapping resources. Most wetland basins that were missed were small temporary or seasonal basins.

Cattail vegetation was more often found in large wetlands and in regimes that hold water on a semi-permanent basis. Wetlands in cropland were least likely to contain cattail and wetlands in perennial cover with a cropping history were most likely to contain cattail. The majority (66%) of wetlands sampled in the NEDP were found in cropland while only 15% were found in a native landscape.

Implications for usage of the National Wetlands Inventory (NWI) dataset were reviewed for the NEDP. The strength of the NWI data in the NEDP is limited for identification of small temporary or seasonal wetlands, particularly in cropland.

Introduction

This study was designed to expand on research done by Ralston et al (2007) where selected sample sites were mapped using GIS to identify wetlands and cattail vegetation. This study will expand on existing knowledge of Prairie Pothole Region (PPR) wetlands which can be used in management decisions.

The PPR of North Dakota has very important wetland attributes caused by glaciations of the region. However, the glacial actions caused very different types of wetland habitat in the region. In areas such as the Prairie & Missouri Coteau, terminal moraines caused larger rolling hills and larger deeper wetlands. In the Drift Plains, glaciers created more flat terrain & ground moraines which resulted in more numerous small, shallow wetlands (Winter 1989). These small wetlands have a high influence of agriculture farming in the Drift Plains as opposed to the primary land-use of ranch/range in the Coteau. To increase crop production the small wetlands are often drained or intentionally filled in. Unintentional filling is also common when these small wetlands are farmed through or simply due to wind and water runoff erosion called siltation (Gleason & Euliss 1998).

The original Ralston et al (2007) study encompassed all parts of the Drift Plains and Missouri Coteau in ND. Due to time and funding restraints this study will only cover the Northeast Drift Plains (NEDP) stratum which according to the previous research contains the most cattail wetlands in the PPR of ND. This study area will assist in answering questions about land use associated with the presence of cattail vegetation and wetland identification in a largely cropland dominated landscape.

Future research may expand this re-evaluation of the Ralston et al (2007) study to include all sample sites in all strata.

As described by Ralston et at (2007), the NEDP has the highest density of wetlands in the PPR and the highest occurrence of cattail vegetation. These factors combined with extensive copping and associated wetland drainage/degradation and habitat fragmentation; provide the U.S. Fish and Wildlife Service Devils Lake Wetland Management District (USFWS-DLWMD) with challenges in managing wetlands in the NEDP. Because of extensive wetland drainage and protection issues the USFWS-DLWMD has developed extensive wetland mapping protocols including importing a wide variety of aerial photos from as many possible resources available for each location to ensure the best possible detection and depiction of wetland basins. Aerial photo resources range from 1950's to current spring and summer photography. While conducting large scale wetland mapping, the importance of the variety and quality of resources has become apparent (Pers. Cor. USFWS 2007).

In the NEDP cattail choked wetlands are common which have reduced functionality to wetland dependant species such as shorebirds and waterfowl. Mechanical sediment removal has become a common tool used in these wetlands as a restoration or enhancement technique. The sediment in wetlands and the presence of cattail has raised questions about how that may relate to the surrounding landuse (Pers. Cor. Mark Fisher, USFWS 2007).

Study Design & Methods

All sample sites within the Northeast Drift Plains from the Ralston et al (2007) study were reviewed using additional tools to identify any unidentified wetland basins and adding new classifications. The original study used 2002 late summer color infrared imagery which was ideal for the purposes of identifying cattail vegetation but was poor for non-cattail wetland identification due to drier conditions in the late season. The study was supplemented with 2003 true color imagery from mid summer taken by NAIP/FSA. This imagery helped with identifying basins; however dry conditions in some areas for 2003 as well as low contrast in some of the imagery limited wetland identification. National Wetlands Inventory polygon layer was used in the original study to assist in identifying areas to focus on as possible wetland locations as well as for classification of wetlands. Topographic layers were also used to identify low areas versus hills.

For this study, all the original tools mentioned above were again used. However, the existing aerial photography was supplemented with NAIP/FSA imagery from 2004-2006 as well as grey scale Digital Orthoquad images from the mid to late 1990's. The NWI point and line features were added to the polygon layer to better portray pre-identified basins and give a complete and accurate representation of the NWI's mapping ability for this area. Land cover maps derived from classification of satellite imagery and provided by the NDSU extension service (2003) and the USFWS 1994 were also incorporated. In addition to the USGS DEM topographic layers previously used, Digital Raster Graphic Maps (DRG's) were also utilized.

Within the NEDP, 30, four square mile sample sites were used totaling 120 square miles. Two of these sample sites were previously categorized into the Southern Drift Plains strata in the Ralston et al 2007 study but with closer review of the original strata boundaries from Stewart and Kantrud 1972 they were found to be better associated with the NEDP. Each sample site was reviewed using all available tools and sources of aerial photography. Wetland basins identified in the Ralston et al (2007) study were compared and verified using the previous and additional tools and changes were made to the size or shape of the basins as needed. Any wetland basins not-identified in the original mapping process were delineated. In most instances wetlands needed to be visually confirmed using more than one photographic resource or other GIS tools unless the wetlands signature was clear enough to remove doubt before it was delineated. After all wetlands were identified, each basin was classified into several categories including, Cowardin et al (1979) wetland system and regime, presence or

absence of cattail vegetation in the year of the original study (2002), if the wetland was also identified by the NWI point, line or polygon layer as well as by the predominate surrounding land cover category. Land cover categories were defined as currently cropped or tilled land, perennial non-native cover with historical disturbance and native, unbroken cover.

Cattail presence, absence or acreage did of course change between years in many of the wetlands. However cattail estimates were left with only that cattail vegetation identified in the 2002 CIR images as it is difficult to compare across years in these dynamic wetland systems. Wetland boundaries were draw based on the best depiction of the basin using all available resources and not necessarily based on current water conditions visible in individual photographs. Land cover classification was done using conditions in 2002 at the time of the cattail estimations for consistency in comparisons.

Results

In all 30 sample sites 6,477 wetlands were identified compared to the previously identified 4,569 basins in the same sample sites by Ralston et al (2007) (Table 1). Of the wetlands identified in the original Ralston et al 2007 study, 100% of those wetlands were also identified in this study. For the NWI dataset, this study identified 90% of the polygon features, 61% of the point features and 62% of the line features.

Table 1. Proportion of Sampled Wetlands also identified by other inventories

	Total Wetlands Identified in this study	Proportion Also Identified by NWI	Proportion Also Identified by Ralston et al 2007
All Wetlands	6,477	73.49%	70.54%
Cropped	4,310	69.47%	64.29%
Non-Native	1,181	79.93%	80.27%
Native	986	83.27%	86.21%
Permanently Flooded	0	NA	NA
Intermittently Exposed	16	100.00%	100.00%
Semipermanently Flooded	527	98.29%	99.43%
Seasonally Flooded	1,497	89.45%	94.59%
Temporarily Flooded	4,437	65.07%	58.89%

Total cattail acreage and basins containing cattail did not change from the Ralston et al (2007) study as that study identified all visible cattail in that time period (Fall of 2002). Size of the basins were compared among water regime and if they were identified by previous NWI or Ralston et al (2007) inventories. (Table 2).

Table 2. Average size (Acres) of sampled wetlands among water regimes, cattail vegetation presence and previous identification.

	All Wetlands	Cattail Wetlands	Non-Cattail Wetlands	Wetlands Identified by NWI	Wetlands Not Identified by NWI	Wetlands Identified by Ralston et al 2006	Wetlands Not Identified by Ralston et al 2007
All Wetlands	1.60	4.11	0.55	2.02	0.43	2.15	0.28
Intermittently Exposed	57.06	95.50	18.62	57.06	NA	57.06	NA
Semipermanently Flooded	8.05	10.82	2.12	8.16	1.23	8.07	4.58
Seasonally Flooded	2.07	3.01	0.88	2.19	1.04	2.16	0.47
Temporarily Flooded	0.47	0.96	0.38	0.53	0.37	0.62	0.27

The proportion of wetlands with cattail decreased from the Ralston et al 2007 study with the addition of the newly mapped non-cattail basins. (Table 3)

Table 3. Cattail vegetation proportions and distributions.

	Proportion of all sampled wetlands that contain Cattail in each classification	% of Cattail Coverage in only wetlands that contain cattail	Distribution of total Cattail Acres among various classifications
All Wetlands	29.44%	44.32%	100.00%
Cropped	23.36%	43.41%	31.42%
Non-Native	45.98%	46.71%	34.66%
Native	36.21%	43.26%	33.93%
Intermittently Exposed	50.00%	12.49%	2.42%
Semipermanently Flooded	68.12%	40.88%	50.44%
Seasonally Flooded	56.05%	47.04%	37.71%
Temporarily Flooded	15.80%	43.18%	9.42%

Distribution of sampled wetlands among land cover classes and water regime were compared against each other. (Table 4 & 5)

Table 4. Percentage of sampled wetlands by Regime in various land cover classes										
	All Regimes		Intermittently Exposed		Semipermanently Flooded		Seasonally Flooded		Temporarily Flooded	
	All Basins	Cattail Basins	All Basins	Cattail Basins	All Basins	Cattail Basins	All Basins	Cattail Basins	All Basins	Cattail Basins
Cropped	66.54%	52.81%	6.25%	12.50%	43.45%	50.14%	46.83%	54.47%	76.16%	52.64%
Non-Native	18.23%	28.47%	43.75%	37.50%	23.72%	25.63%	21.91%	25.86%	16.25%	32.95%
Native	15.22%	18.72%	50.00%	50.00%	32.83%	24.23%	31.26%	19.67%	7.60%	14.41%

Table 5. Percentage of sampled wetlands by land-cover classes in various water regimes								
	All Land Classes		Cropped Landuse		Non-Native Cover		Native Cover	
	All Basins	Cattail Basins	All Basins	Cattail Basins	All Basins	Cattail Basins	All Basins	Cattail Basins
Intermittently Exposed	0.25%	0.42%	0.02%	0.10%	0.59%	0.55%	0.81%	1.12%
Semi-permanently Flooded	8.14%	18.83%	5.31%	17.87%	10.58%	16.94%	17.55%	24.37%
Seasonally Flooded	23.11%	44.00%	16.26%	45.38%	27.77%	39.96%	47.46%	46.22%
Temporarily Flooded	68.50%	36.76%	78.40%	36.64%	61.05%	42.54%	34.18%	28.29%

Discussion

Identification of wetland basins is much greater (about 30% in this study compared to Ralston et al 2007 and NWI) when more resources are used to identify them. Wetlands are dynamic systems and their visual presence is related to many factors associated with present water conditions. Water conditions vary greatly between years as well as within the year. In the NEDP the National Wetlands Inventory used spring color infrared photography from one year in the late 1970's to 1980. Spring imagery is ideal for wetland delineation since wetlands are normally at their highest functional potential for the year. However, even using ideal imagery there are often questionable features that without other photographic resources to compare against, many wetlands can not be properly identified or some features are misidentified as wetlands. The Ralston et al 2007 study used 2 sources of imagery which provided a second resource to compare questionable features against, however the timing of both of the photographs was not ideal for optimal water conditions resulting in unidentified basins.

The majority (>95%) of wetlands identified in this study that were not identified in Ralston et al 2007 or NWI were temporary and seasonal basins. By definition these basins are small and shallow and may only hold water for a short time in the spring and will be dry by the end of the growing season. The ephemeral nature of these wetlands can make them difficult to detect when dry, especially when they are often cropped or hayed through when possible. Although temporary and seasonal basins may not function for the entire year they serve a very important purpose as waterfowl pair ponds and aquatic dependant avifauna habitat.

A relationship between wetland size and cattail vegetation was noted in Ralston et al 2007 where larger wetlands are more likely to contain cattail. This may be due to larger wetlands often tending to be deeper and contain moisture for longer periods of time which promotes cattail growth. An intuitive relationship was also found in this study where wetlands that were not identified by

previous inventories, tended to be smaller than those that were identified in both inventories. Smaller wetlands may be obscured by surrounding vegetation or by the current land cover type when they are dry. Contrast and resolution quality of the imagery used may also inhibit the identification of smaller basins.

Nearly 30% of all wetlands sampled contained cattail, however that proportion does not hold true among all land cover categories. Less that a quarter of wetlands in a cropped landscape contained cattail. This is likely due to farm practices of tilling and planting through any wetland that are accessible with the equipment to increase plantable acres, decrease obstructions to improve efficiency in farming and reduce blackbird roosting sites as a depredation management tool. The native and non-native land cover classifications both involve perennial cover and aside from grazing, haying or clipping, provide for a relatively undisturbed vegetative cover. However there is a difference in the proportion of wetlands in these two classes that contain cattail. Within the sample sites, a wetland in native habitat is 10% less likely to contain cattail than in non-native habitat. The prior disturbance or cropping history of non-native wetlands may result in better growing conditions for cattail vegetation. Disturbed soil and exposed mudflats or seed banks may favorably select for aggressive species such as hybrid cattail where native wetland plants can exclude cattail to a degree if left undisturbed. Sedimentation and nutrient loading due to wind and water erosion into cropped or disturbed wetlands also may enhance cattail growth providing a soft nutrient rich growth platform that perfect for cattail. When the land is no longer cropped or disturbed the active management for cattail ceases thus giving non-native wetlands the highest likelihood of containing cattail.

The NEDP is a cropland dominated, grass fragmented landscape. Over 66% of all sampled wetlands were found in cropland with only about 15% found in native landscapes. Temporary and Seasonal wetlands are the highest risk for degradation due to filling in by sedimentation or draining for agricultural use due to their small, shallow size. Over three quarters of all temporary wetlands and nearly half of the seasonal wetlands identified were in cropland.

Sediment removal is a technique often used by the USFWS in the NEDP to restore wetlands degraded by reduced water holding capacity as well as choked by cattail vegetation. According to Partners for Fish and Wildlife Biologists' in the region, removing the sediment reduces the monotypic cattail environment and increases the hydrophyte diversity which has greater benefit to many wildlife species. Sediment removal is only done on basins in a perennial cover environment for longer term benefits. In most cases temporary and seasonal basins are the only wetlands eligible for sediment removal due to restrictions of getting equipment into basins because of water conditions as well as elevated cost for the increased workload in larger basins (Pers. Cor. Mark Fisher, USFWS 2007). Within the perennial cover habitats, the proportion of sampled wetlands that contain cattails as well as those that are in the lower water regimes is fairly high but due to the highly cropped landscape in the NEDP the proportion of potential sediment removal wetlands as a whole is low. Of the wetlands sampled in this study, only about 11% of all wetlands are eligible for sediment removal based on presence of cattail, perennial cover environment and temporary or seasonal regimes.

NWI Implications

The National Wetland Inventory dataset is the most complete wetland inventory available in many areas and therefore is widely used. The NWI data has been used in large landscape level modeling (USFWS, R&W, Reg. 6, 1996). It is important to recognize limitations of the dataset as it relates to the strength of the models derived from the NWI data.

As indicated above NWI identified about 74% of the wetlands delineated in this study. The NWI did indicate wetlands in some locations that were not identified by this study. This study identified 90% of the polygon features, 61% of the point features and 62% of the line features for a total average of 85% of NWI features also identified in this study. This study did not intentionally map

line features such as roadside ditches or drainage ditches unless it contained cattail vegetation or was a significant riverine system which accounts for much of the discrepancy of this feature type. Points were used in the NWI to indicate wetland too small to draw a polygon. The polygon features that were identified by NWI and not by this study averaged 0.84 acre in size. Of the wetlands that were not identified in this study 99% were also temporary or seasonal wetlands. The discrepancies between the two inventories are likely the result of two scenarios in the identification process. First, either water conditions or vegetation clues were not sufficient enough to identify a wetland in a particular image which is reasonable with very small, lower water regime wetlands. The second theory is some of the indicated basins were misidentified land features that are not actually wetlands. Misidentification is more likely when only one imagery source is used in delineation.

When using aerial photography to identify wetland basins it is important to use multiple sources of imagery encompassing a multiple year span as well as correct timing within the year. In this study imagery was used spanning approximately one decade which covered some variation in wet and dry cycles. Five of the six years of photography used were approximately taken during the same time of year; mid-summer. However variability within the images was great. Many of the smaller or more temporary basins had almost no visual signature in some years but were very clear in others. Observational notes for study sites in the NEDP indicate the 2005 NAIP/FSA imagery often provided the best visual signatures of wetlands out of all imagery used.

The original spring CIR slide film used in the NWI delineations (1975-1981) was available for some but not all sites so it was not used for wetland delineations to keep proper consistency among all sample sites. The NWI film was scanned and imported into the GIS for subjective evaluation. Observations indicated small wetlands particularly in cropland were often hard to clearly identify. Color infrared film is most useful in distinguishing vegetation as chlorophyll reflects a red signature and water/moisture absorbs near infrared light thus showing up as a dark or black signature (Lillesand and Kiefer 1987, Kumar 2002). Moist bare crop soil often was very dark in the spring NWI images which often were indicated as a wetland by the NWI. Moist soil alone during spring runoff does not necessarily indicate a true wetland. With the usage of six sources of imagery in this study along with the other resources used it is reasonable that if a wetland was not identified it was either not a wetland at all or it was a very ephemeral wetland that has limited habitat function to wetland dependant species.

Unless another complete inventory of the region is done, the NWI dataset will continue to be used as the most comprehensive dataset available from many areas. However, it should be recognized the major limitation of the NWI in the NEDP as well as possibly other wetland inventories in regions with similar conditions to the NEDP of ND is correctly identifying small temporary and seasonal wetlands specifically in cropland. This possibly could affect habitat modeling that is sensitive to species using these small wetlands such territorial breeding waterfowl like Mallards, Gadwall and American Widgeon during pair formation. More data is needed before making any definitive conclusions.

Literature Cited:

Kumar, D. N. 2002. Energy Interactions with the Earth Surface. Civil Engineering Department, Indian Institute of Technology, Kharagpur, Unpublished Data.

Lillesand, T. M., and R. W. Kiefer. 1987. Remote sensing and image interpretation. John Wiley & Sons, New York, New York.

Ralston, S. T., G. M. Linz, W. J. Bleier., H.J. Homan 2007. Cattail Distribution and Abundance in North Dakota. Journal of Aquatic Plant Management. 45:21-24

Stewart, R. E. and H. A. Kantrud. 1972. Population estimates of breeding birds in North Dakota. The Auk 89:766-788

U.S. Fish & Wildlife Service, Refuges & Wildlife, Region 6. 1996. Using Landscape Information Approaches to Increase Duck Recruitment in the Prairie Pothole Region. 61st North American Wildlife and Natural Resources Conference.

Winter, T. C. 1989. hydrologic studies of wetlands in the northern prairie. Pages 16-54 in A. G. van der Valk, editor. Northern prairie wetlands. Iowa State University Press, Ames.