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Inland (Non-Tidal) Wetland Mapping

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Abstract: *The U.S. Geological Survey has prepared three experimental wetland maps for the Auburndale, Florida 1:24,000-scale quadrangle. Wetland classes and boundaries were interpreted from quad-centered high-altitude color-infrared and superwide black-and-white panchromatic photographs onto a black-and-white orthophoto base map made from a color infrared photograph.*

Three wetland classification systems were tested for possible production use by Geological Survey compilers: the Martin system, the Anderson system and the Cowardin system. The finished maps were compared with standard Geological Survey 1:24,000-scale maps in terms of detail shown and utility of each classification system. The Cowardin system was judged to be the best of the three systems to apply on a national basis because the definitions were easier to apply in the photoidentification process and the density and variety of wetland classes was greater than when the other systems were used as the basis for classification.

Introduction

As awareness of wetland values increases, inland wetland classification and mapping is becoming a matter of great concern for local, State, and Federal agencies. Wetlands were once considered a hindrance to land development, and large grants of money were made to reclaim these areas for productive agricultural use or construction sites. Now, legislation is being enacted to protect and, in some cases, acquire wetlands, but the lack of a viable definition and accurate delineation criteria hinders implementation of the laws. Classification and mapping of wetlands are needed to establish a basis for their evaluation and management.

The U.S. Geological Survey (USGS) is experimenting with new compilation methods and map products using three different wetland classification systems. Experimental wetland maps have been prepared for the Auburndale 7.5-minute quadrangle in Florida.

Objectives

The objectives of this research project were (1) to test the feasibility of mapping and classifying inland (non-tidal) wetlands on USGS 7.5-minute quadrangles in more detail than is presently shown; and (2) to develop or identify a standard definition and classification system for possible use by the Geological Survey.

Wetland Classification Systems

Three classification systems were tested on the Auburndale, Florida quadrangle; Martin (Martin *et al.*, 1953), Anderson (Anderson *et al.*, 1976), and Cowardin (Cowar-

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din *et al.*, 1976). These three systems were intended for nationwide usage. They differ in scope, terminology, and criteria and provide several different approaches to the mapping of wetlands on USGS 7.5-minute quadrangles. Many excellent classification systems have been written for local or regional conditions, but regional or local systems cannot usually be applied in different regions of the country. Thus, they are neither applicable to a national wetland mapping program nor to standard treatment on USGS 7.5-minute topographic quadrangles and they were not considered in this research.

Martin System. The Martin System was developed for the first U.S. Fish and Wildlife Service (USFWS) wetland inventory in 1954 (Shaw and Fredine, 1956) and has been one of the most common and influential tools in the preservation of the nation's wetland resources. The system was designed for national use, and the 20 classes are intentionally broad categories with primary emphasis placed on the value of wetlands for wildlife in general and waterfowl in particular. The wetland classes are grouped under four categories: Inland Fresh Areas, Inland Saline Areas, Coastal Fresh Areas, and Coastal Saline Areas. These types of aquatic environments furnish essential habitat for all waterfowl, most species of fur animals, and many species of farm game, forest game, and warm-water fish. In each category, the types are arranged in order of increasing water depth during the growing season. This study was limited to the eight wetland types in the Inland Fresh Areas category.

Anderson System. The Anderson System is a complete land-use and land-cover classification system based almost entirely on the use of remote sensor data. The System is hierarchical in nature, proceeding from the very general at Level I to the more explicit at the higher-numbered levels. Wetland, one of the nine Level I categories, is divided into Forested and Non-Forested at Level II. The system was intentionally left open-ended with the intent that Levels III, IV, and so on would be developed by the user groups themselves, so that their specific needs might be satisfied by the categories they introduce into the structure. For this project, we have sub-divided the Level II classes into Level III and IV for mapping at 1:24,000-scale, so that the amount of detail extracted would be more compatible with the Martin System. The Wetland classes are based on vegetation and presence of water or wet soil.

Cowardin System. The Cowardin System is being developed by the USFWS to replace the Martin System for a new national inventory of wetlands. While the Martin System had as its single purpose the assessment of the amount and types of valuable waterfowl habitat, the new system is designed to be more widely used and it is therefore vastly broader and more complex. The three primary objectives of the Cowardin System are (1) to group ecologically similar habitats; (2) to furnish habitat units for inventory and mapping; and (3) to provide uniformity in concepts and terminology throughout the United States. It is a hierarchical descriptive system based upon vegetation, soils, and hydrology and intended to facilitate inventory and comparison of wetland types on a national basis. The system was designed to place wetlands with similar hydrologic, edaphic, and botanical characteristics in the same or closely related classes to provide information for a wide variety of users. The authors made no attempt to tie the classification directly to remote sensing. Photointerpretation coupled with field inventory is needed for complete system classification.

CURRENT GEOLOGICAL SURVEY WETLAND MAPPING

The USGS 1:24,000-scale topographic maps have shown inland wetlands as a hydrologic feature for many years. A *swamp* is defined as a low-lying, wet, spongy land saturated and at times covered with water. The water cannot drain from the land because of flat terrain, impervious material, or vegetation. Swamps usually contain trees and (or) shrubs. A *marsh* is defined as a wet or periodically inundated, treeless land generally characterized by grass or reeds.

In stereocompilation of topographic maps, wetlands are shown with dashed outlines and labeled. On the published map the outline is omitted, and the area is overprinted with the swamp and marsh symbol. If a wetland is normally submerged, as at the head of a lake, it is outlined with a blue boundary and overprinted with the water tint. Definite water channels within a wetland are shown as perennial streams. Mangrove swamps on tropical and semitropical coastlines are shown by the mangrove symbol, and other wooded swamps are shown by the wetland symbol overprinted with the woodland tint. Marshes are shown by the wetland symbol alone or overprinted with a blue tint.

In Georgia (Tifton West Quadrangle, not shown), the Geological Survey experimented with cartographically portraying more wetland information than is presently shown on our 7.5-minute quadrangles. Wetland boundaries appear in blue and vegetation (woody plants) in open water as depicted by overprinting blue and green without the use of the tufted grass symbol. At present, however, there are no uniformly established rules of symbolization to represent this type of information on Geological Survey maps. This is not necessarily an oversight or an attempt to suppress valuable information, but rather a lack of user demand for this type of information. One of the main objectives of this research project is to determine how much wetland information can be shown on our 7.5-minute quadrangles, with a minimal amount of cartographic effort, that will be both qualitatively and quantitatively acceptable to users. It is the desire of the authors to investigate the feasibility of mapping all photoidentifiable wetland parameters at 1:24,000 scale within the limitations of the Geological Survey Mapping Centers; and to exploit this capability to develop a more meaningful and manageable wetland mapping program.

Test Area

The Auburndale, Florida, 7.5-minute quadrangle area, located approximately midway between Tampa and Orlando, was selected as a test site because the geology within the area covered by the map is complex and a variety of wetland types are present. The eastern third of the area is covered by a Central Florida Highlands limestone formation or karst topography with many sink-hole lakes interconnected by canals with control dams. The central and western parts of the area are relatively flat lowland covered by marine shore deposits, and extensive phosphate strip mining areas are located in the western edge. Due to the shallow depths of the phosphate beds, generally less than 40 feet, strip mining techniques are employed almost exclusively throughout the area.

An acidic mixture of water, clay, and unextracted ore remaining after mining is put into holding ponds (diked, previously stripped areas) to allow the solids to settle. Some of these mines are quite old and most of them, diked for control of mine wastes, are now shrub covered. Spoil piles and ridges are very evident in some of these sites, while others have a flat floor. All sites show evidence of being wetland, but permanence of standing water (water regime) is difficult to determine.

Saddle Creek, a tributary of the Peace River, runs across the Southwest corner of the quadrangle and drains into Lake Hancock located on the south edge. This creek flows through a narrow open channel covered with water hyacinth (*Eichhornia* sp.). There is no definite shoreline or bank as the rest of the stream bottom is covered by forested wetland, predominantly cypress (*Taxodium* spp.). Where the creek enters Lake Hancock there is a wide band of emergent vegetation, mostly pickerel weed (*Pontedaria* sp.) and water hyacinth, showing a brilliant red signature on the CIR (color infrared) photographs.

The area between Saddle Creek and the limestone formation to the east has many small wetlands. Some of the wetlands appear on the aerial photographs as very shallow, round or oval depressions seemingly devoid of shrubs or trees except near the center of the feature. Other wetlands of similar shape have heavy tree growth with pure stands of cypress in some and live oak (*Quercus virginiana*) and pine (*Pinus* sp.) species in others.

The higher, well-drained ground of the limestone formation is occupied by large citrus groves. Absence of trees in the citrus groves serves to indicate the low spots in this karst topography because citrus trees will not thrive in places where water will stand for even short periods of time (two or three weeks). The rest of the highland area is urban (Auburndale and Winter Park) with urban development spreading into the lower elevations west of the limestone ridge, sparing the citrus plantations. The newly developed urban or suburban area was seemingly too wet for farming of cultivated crops because a wet soil signature occurs throughout this section on the CIR, even in areas now being developed for housing. The wetlands in the areas under development are being cleared and drained. The wettest part of the tract is dredged to improve drainage and the dredged soil is used to raise the part of the land where a dwelling(s) will be located. Permanent, small, usually rectangular lakes surrounded by houses are now fairly common.

The remaining low open areas in this section of the quadrangle show evidence of being mowed, either for hay or to control the coarser weeds and grasses, which makes these areas more suitable for pastureland. Water holes for livestock are created by bulldozing a relatively thin layer of topsoil when the water table is at or near the surface. Major roads and railroads crossing the lowlands appear to be elevated on fill. Numerous borrow pits exist along the routes; some are water filled, whereas others appear to be flooded seasonally. Some of the sinkhole lakes show dramatic declines of water levels in the recent past whereas the water levels of others appear very stable.

Methods and Materials

Two sets of aerial photographs were used to interpret and delineate wetland boundaries and classes in the Auburndale, Florida test site. Table 1 gives details on cameras, film types, and flights.

Two partial field checks of the Anderson System compilation were done and a limited number of 35 mm slides of the wetland areas were forwarded to the compiler for evaluation and aid to wetland classification.

For the test compilations, photoimage bases at 1:24,000 scale were made from the quad-centered CIR photographs by making a rectified black-and-white film transparency and overprinting it on yellow scribecoat sheets. Using a Kelsh Plotter, the three wetland classification systems (Martin, Anderson, and Cowardin) were compiled stereoscopically on these photoimage bases. A Teledyne Post Microfiche Viewer, converted to accept 9- by 9-inch positive phototransparencies, was used to enlarge up to 16×, small areas as an identification aid for complex wetland features.

The three image wetland classification maps contain a geographic reference system, major geographic names (cities and lakes), and appropriate standard collar information. In addition, an explanation depicting the map symbols for the categories of the appropriate wetland classification system is contained in the collar on each map.

To facilitate comparisons, simplify the mapping, and devise a manageable map symbolization code to identify the wetland classes, only the photoidentifiable parameters of the Cowardin System associated with vegetated inland wetlands were considered. Beaches, flats, rocky shores, and bottoms were not mapped. The codes or symbols used for the Cowardin, Anderson, and Martin Systems are shown with Figures 1, 2, and 3, respectively.

Results and Discussion

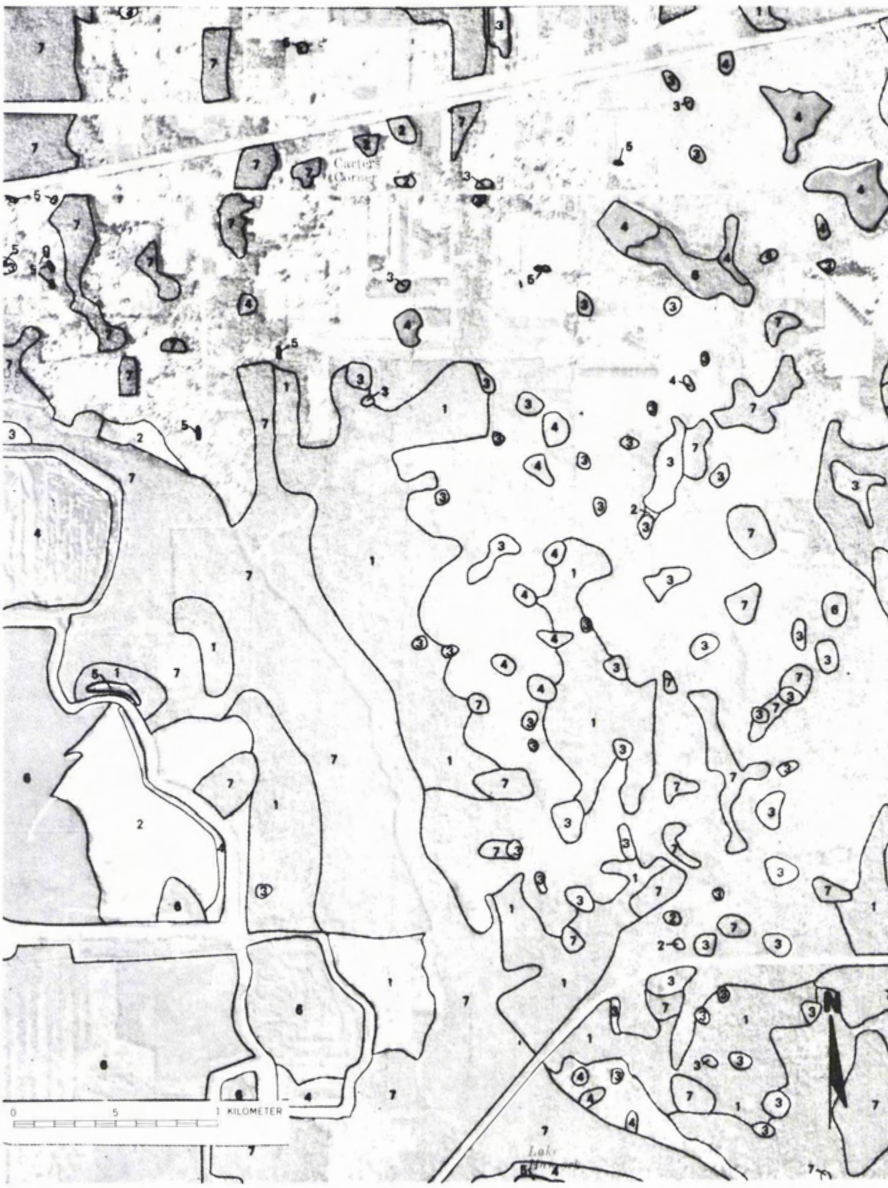
Three wetland maps were prepared for the Auburndale, Florida 7.5-minute quadrangle by interpretation of CIR photographs onto a black-and-white orthophotoquad base. Figures 1, 2, and 3, respectively, show the southwest quadrant of the Martin, Anderson, and Cowardin wetland classification maps. The three wetland maps illustrate the delineation of the wetland classes with appropriate map symbols of each of the three wetland classification systems tested. Figure 4 represents a part (southwest quadrant) of the Auburndale quad as it was mapped in 1944 and Figure 5 is the same area which has been recently (1975) revised. Figures 4 and 5 show the wetlands as they are represented in standard 7.5-minute quadrangle mapping. The wetland boundaries are indefinite and only the distinction between marshes and swamps is made.

The Martin System proved very difficult for wetland mapping. Positioning of the wetland-upland boundary in timber stands and then separating class 1, seasonally flooded flat, from class 7, wooded swamp, was complicated by the vagueness of the system definitions. Other wetland classes were equally difficult to map based on definition alone. For example, the term bog is defined in terms of species that overlap with those found in wooded swamp. The information to be gained from separating these classes appears minimal because interpretation is extremely subjective. The Martin System was found not suited for large scale wetland mapping. Therefore, no advantage can be inferred in applying the Martin System in preference to the Anderson and Cowardin Systems. The problems associated with the use of the Martin System can be summarized as follows: (1) Definition of categories too broad to adequately accommodate regional differences; (2) lack of pre-

Table 1. Camera, Film Type, and Flight Information for Aerial Photographs*

Film	B/W Panchromatic	Color Infrared
Camera	Wild RC-9	Wild RC-8
Lens	Super Aviogon	Universal Aviogon
Focal length	88.36 mm	152.21 mm
Focal height	6000 ft.	38,000 ft.
Scale	1:20,000	1:76,000
Date	Nov. 30, 1971	Dec. 1, 1972
Season	Dry	Dry

* The use of brand names in this report is for identification purposes only and does not imply endorsement by the Geological Survey.



MARTIN INLAND WETLAND CLASSIFICATION

1 Seasonally Flooded Flat
2 Wet Meadow
3 Shallow Marsh
4 Deep Marsh
5 Open Water
6 Shrub Swamp
7 Wooded Swamp
8 Bog

FIG. 1. Southwest corner of the Auburndale test area, classified using the Martin System.

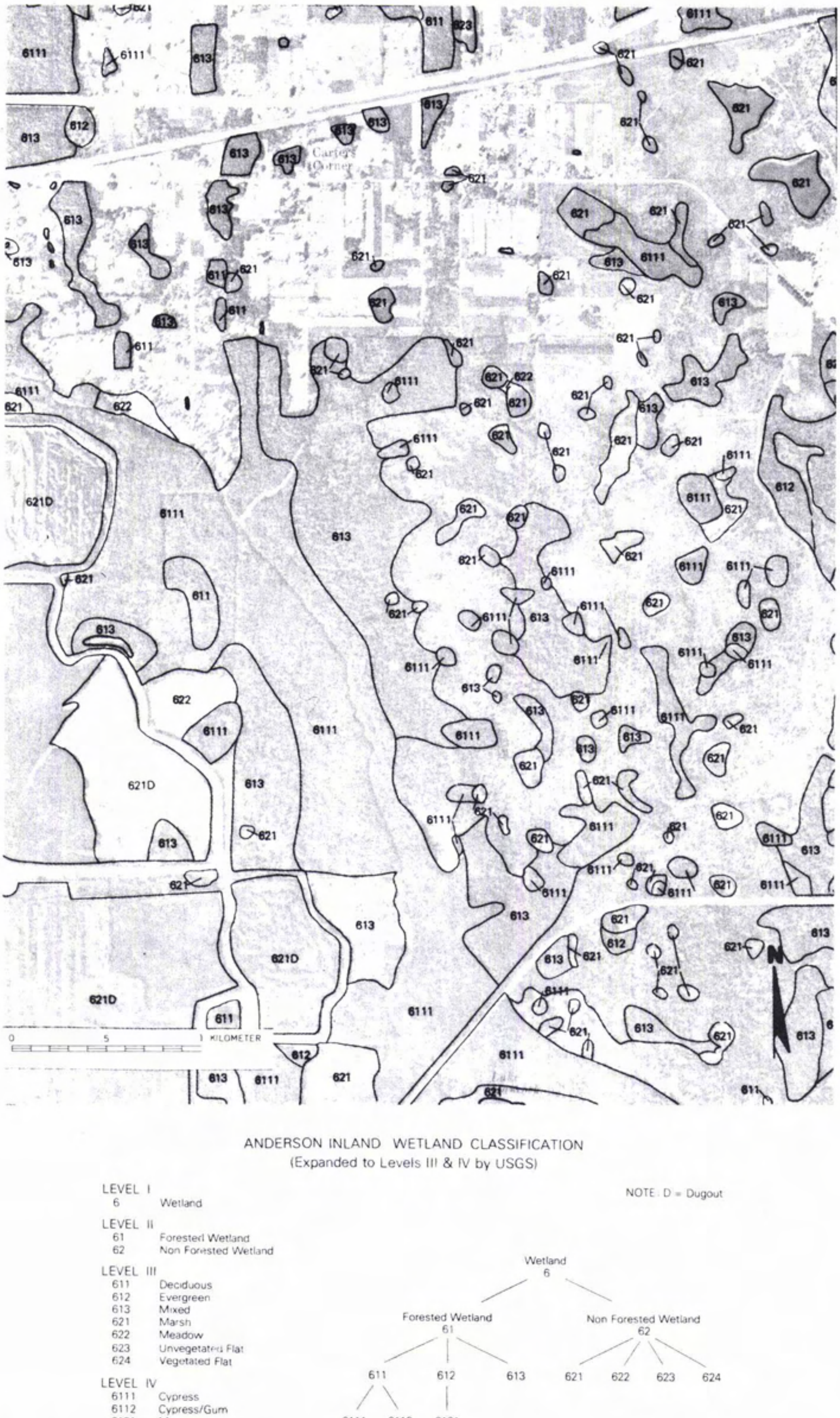
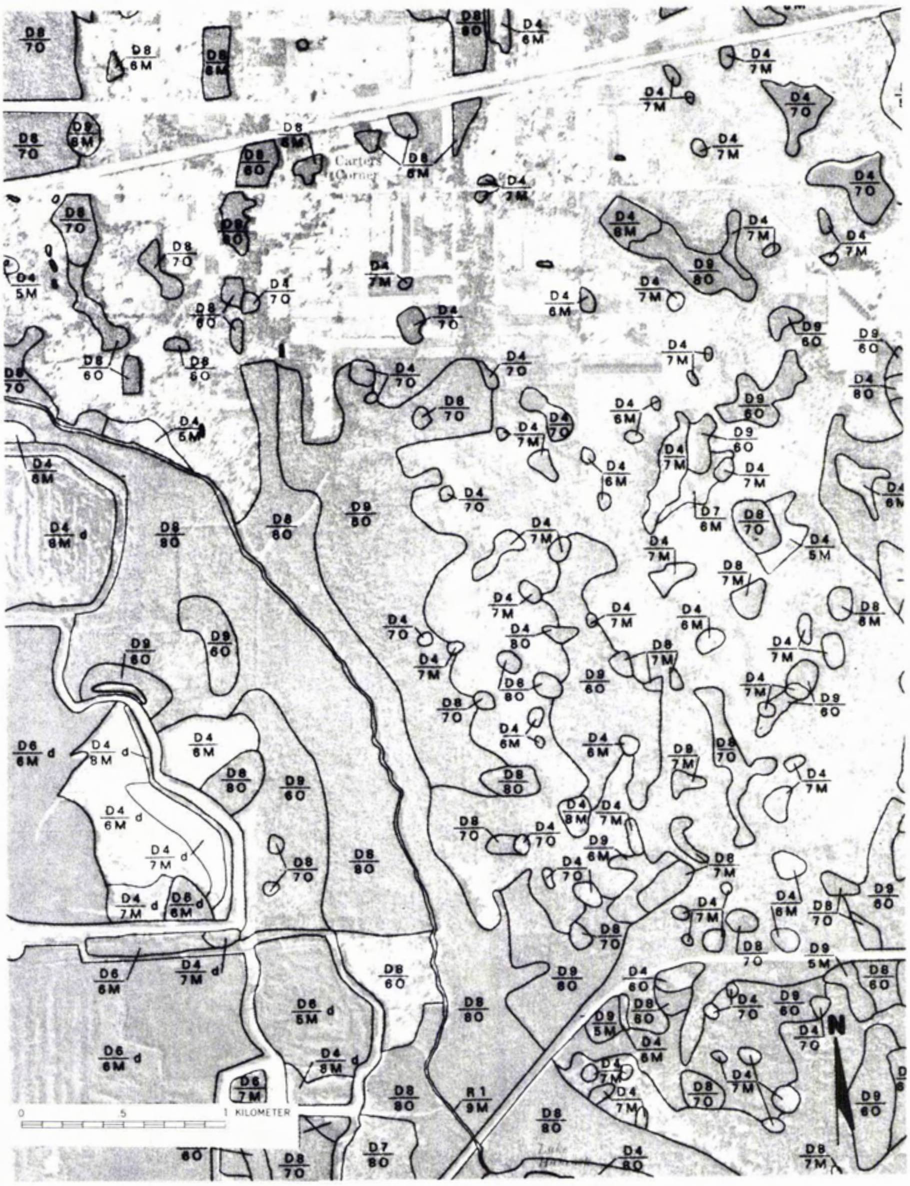


FIG. 2. Southwest corner of the Auburndale test area, classified using the Anderson System.



COWARDIN INLAND WETLAND CLASSIFICATION (Modified by USGS)

ECOLOGICAL SYSTEM
- R Riverine
- L Lacustrine
- D Palustrine

CLASS AND SUBCLASS
- 1 Pools
- 2 Riffles
- 3 Floating-Leaved Bed
- 4 Emergent Wetland
- 5 Moss/Lichen Wetland
- 6 Deciduous Shrub Wetland
- 7 Evergreen Shrub Wetland
- 8 Deciduous Forested Wetland
- 9 Evergreen Forested Wetland

WATER REGIME
- Tidal { 1 Irregularly Flooded
- 2 Regularly Flooded
- 3 Subtidal }
- 4 Saturated
- 5 Temporarily Flooded
- 6 Seasonally Flooded
- 7 Semipermanently Flooded
- 8 Permanently Flooded
- 9 Intermittently Flooded

ORDER
- M Mineral
- O Organic

SPECIAL MODIFIERS
- i Impoundment
- d Dugout
- c Canal
- ch Channelized
- ir Irrigated
- f Farmed

Example:
Ecological System: Palustrine
Class/Subclass: Evergreen Shrub Wetland
Water Regime: Permanently Flooded
Order: Mineral
Special Modifier: Impoundment

D 7 8 M i

Map Code = D7 / 8M i

FIG. 3. Southwest corner of the Auburndale test area, classified using the Cowardin System.

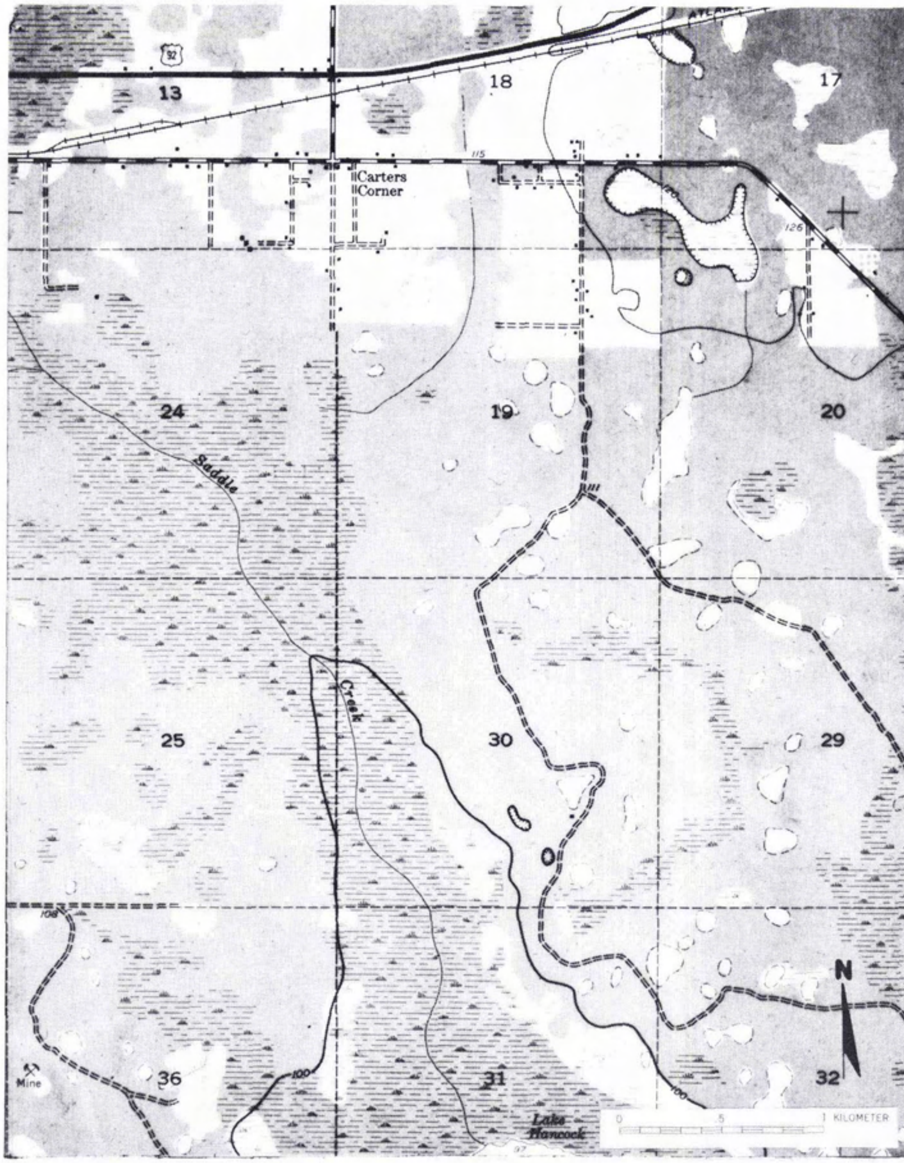


FIG. 4. Southwest corner of the Auburndale test area as mapped in 1944.

cision in definition leading to differences in application; (3) failure to recognize the dynamic nature of wetlands; (4) exclusion of important permanent water bodies (lakes, streams, and rivers); and (5) little or no detail on hydrology and soils.

For our purpose, the wetland classes of the Anderson System were extended to levels III and IV because Level II is not sufficiently detailed for many users. The most attractive feature of the Anderson System was the labeling, that is, an enormous amount of information could be described by a 3 or 4 digit map symbol. The system is hierarchical by design as detail becomes more specific with each succeeding digit. For example, a 6111 map symbol would describe a forested wetland, deciduous, predominantly cypress. Information on soils and water regime are not included in this system, but could be included on a regional basis. However, this flexibility in system definition can also work to disadvantage with different local, State, and regional jurisdictions applying level III and IV wetland definitions to suit their own purposes for inventory, with lack of consideration for compatibility with other users. Another dis-

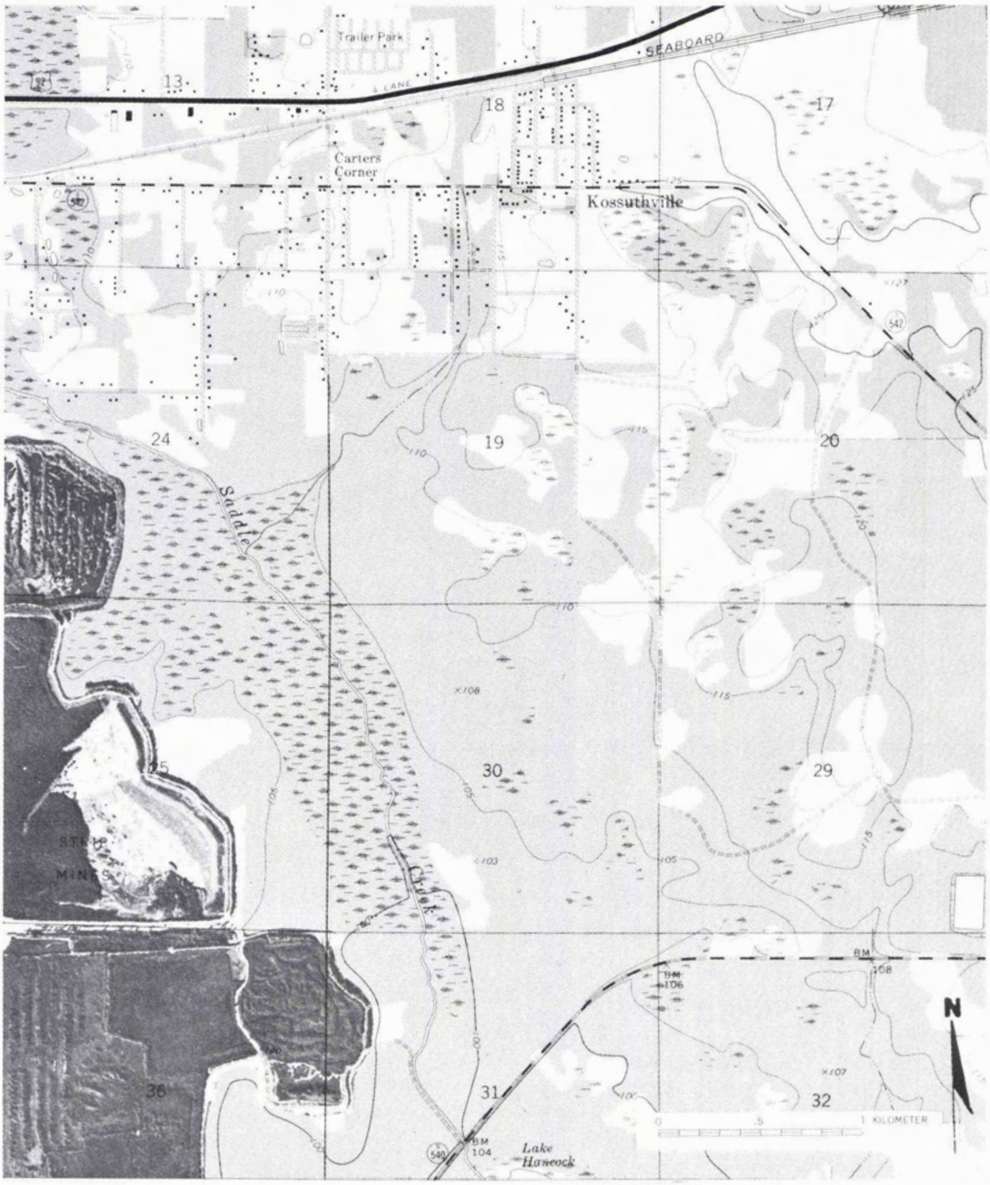


FIG. 5. Southwest corner of the Auburndale test area as mapped in 1975.

advantage to using the Anderson System is that certain level I categories such as wetland used for pastureland, shallow water areas where aquatic vegetation is submerged, cultivated wetlands such as the flooded fields associated with rice production and developed cranberry bogs, and wetland areas drained for any purpose would not be included in the Wetland category. These areas would be classified as Agricultural Land, Water, or one of the other Level I categories.

The Cowardin System, on the other hand, was designed to be used for a national wetland inventory. Of the three systems tested, the Cowardin definitions were the easiest to apply in the photoidentification and delineation of the wetland classes.

The utility of the Cowardin System is due, in part, to the hierarchical structure of the system, which permits both generalists and specialists to work within the same framework, and to the broad range of descriptive identifiers available to the interpreter to define the wetland class. By system design, the compiler uses a logical sequence of deductive reasoning to proceed from the general to the very specific characteristics of wetland habitat. For example, a wetland labelled $\frac{D6}{6M}$d represents a Palustrine wetland that is seasonally flooded, covered with deciduous shrubs, and has a mineral soil type. The Special Modifier, dug-out, (d), also indicates that the area has been disturbed (phosphate strip mining in the case of the Auburndale quadrangle), abandoned, and is reverting back to the natural state. Determination of soil type from aerial photographs will be difficult, but knowledge of an area should aid in making this decision.

The advantage of the Cowardin System is that, once a wetland has been classified by remote sensing techniques, enough definitive information is available to management for evaluation and field inventory decisions. For a complete wetland inventory, users would possess an accurate wetland base map to which they could add their field sampling data (ecological sub-system, order, water chemistry regime modifiers, acreage, and species). Using remote sensing techniques and a modified Cowardin System, we were able to compile a greater density of wetland classes than could be compiled using either the Martin or the Anderson System. We concluded that it is the preferred system for wetland mapping on a regional or national level.

PROBLEMS WITH STANDARD QUADRANGLES

Wetlands are dynamic ecosystems with fluctuating boundaries, as opposed to many of the features ordinarily found on USGS maps. They are a combination of hydrologic regime, vegetation, and soils that varies from one part of the country to another. This characteristic variability is probably the basis of most of the problems encountered in mapping wetlands whether as a routine compilation task for USGS or as an experimental project such as this one. Changes in wetlands and wetland boundaries occur in response to many factors. Wetlands can be created, altered, or destroyed by floods, seismic disturbances, stream channel alterations, draining or damming, and variations of the hydrologic cycle. In some environments, water depth changes of a few inches can shift the wetland boundary by hundreds or even thousands of feet horizontally. Discrepancies noted between map products can usually be traced back to the season chosen for acquiring the mapping photography and for making the field checks.

One real problem for map users attempting to determine size and continuity of wetland categories, is the indefinite wetland-upland demarcation. Marshes and swamps are identified by a randomly spaced tufted grass symbol, interspaced with horizontal lines, and having no outline. The marsh and swamp boundaries, lost by symbolization, cannot be measured in terms of the map accuracy statement. A solid outline is now used to define submerged wetland categories; this line is actually as difficult to determine and position as the wetland-upland boundary. In nature the submerged marsh and swamp boundaries are as nebulous as those of marsh and swamp, but the solid outline insinuates much greater accuracy on the published map. The problem is further compounded by imprecise or inconsistent terminology. For example, the Geological Survey uses the terms marsh and swamp interchangeably and applies "wooded marsh" as a title for the symbol containing swamp. The term, wooded marsh, is a misnomer because the presence of trees and shrubs in a wetland is what separates marsh from swamp.

Comparison of the wetland classes presently shown on the 7.5-minute quads with those on the wetland maps made in this study show a major difference in the amount of information conveyed to the user. All the maps indicate the existence of wetland but the upland boundary on the 7.5-minute quadrangle could be substantially in error because maps are field-checked during the dry season and the absence of a solid line precludes exactness in boundary determination. The USGS alternatives, swamp or marsh, give information only on the presence or absence of trees. The USGS use of submerged categories represents a positive effort to convey information on water regime; however, uniformity in seasonal determination of water levels is important for standardization of map products. Also, the traditional choice of spring, leaves-off photography, results in the omission of marshes where vegetation is seasonally emergent unless a field check in the growing season detects such vegetation (Carter and Stewart, 1977). CIR photographs taken during the growing season can be used to correct this omission.

DELINEATION PROBLEMS

It is probably impossible to provide information on water regime to the detail required by the Cowardin System. Because of water level variations, it is doubtful that a single-line boundary can and should be placed around all wetlands. Surface water may only be present in a wetland during part of the year. The interpreter may be faced, as is often the case, with two sets of photographs, taken at different times, one showing a broad extent of standing surface water and the other showing water only in the large drainage channels. Several alternatives for giving water regime information are possible. If a line is placed around a wetland using standard leaves-off, spring photographs, this line most often reflects a high water boundary. When the position of the line is changed by field check, or additional photographs, both lines could be retained with the inner or wetter part retaining the marsh/swamp symbol indicating a permanent or semi-permanent inundation. The outer part might be displaced with a symbol or legend encompassing the less frequently inundated wetland classes (e.g., occasionally flooded). USGS and other agencies monitor stage (water level) in many U.S. streams and lakes. It may be possible to include on the map collar information which ties the high water to a stage-duration curve. While the details of such a system remain to be worked out, the TVA and the Geological Survey have recently published a wetland map with such information on the collar (Carter *et al.*, 1977).

During this study, one problem encountered in the determination of wetland boundaries and in the identification of wetland classes was difficulty in identifying vegetation, partly because of a lack of seasonal CIR photography. The dormant season is very short in Florida, and many deciduous trees appear to lose leaves all year round. Separation of pine, cypress, and mixtures of either with broad-leafed evergreen (live oaks, bays) was difficult because healthy cypress has a spectral signature similar to pine on CIR photographs taken in late November or early December. Photographs taken in February might have helped separate these two species. We felt that in most cases pure stands of cypress were correctly identified, but that the mixtures were subject to errors in classification. Pine and cypress fortunately were not usually found in the same wetland. The superwide black-and-white photographs at 1:20,000 scale were used as a supplement to the CIR photos in photointerpreting the forest cover types because they contained more information on crown shape and tree height. Floating-leaved, rooted aquatics present a special problem to the compiler. The signature of water lilies (*Nymphaea* sp.) is like that of free-floating plants such as water hyacinth and duckweed (*Lemna* sp.) which should be ignored because they are variable in location and do not compose a Cowardin wetland class. Possibly only field checking can give certainty to the floating-leaved beds class unless a definitive signature can be established.

ORTHOPHOTOQUADS

In many areas, available 1:24,000-scale topographic maps could be used as the cartographic base. However, the orthophotoquad entails minimal cartographic treatment, is substantially cheaper to produce and reproduce, and is the most up-to-date of the alternatives for wetland base maps. Only a few selected names and a grid reference system are portrayed. The monocolor photograph itself provides the planimetric information, and the contours can be added if desired. Orthophotoquads used in conjunction with remote sensing data can provide needed information on wetland boundaries, size, vegetation species, and land-water interface (Carter *et al.*, 1977).

COMPILER TRAINING

We feel that the experienced compiler would require very little training in applying the Cowardin System with remote sensor data. The bulk of this training would be concentrated in learning the classification system with some familiarization in the use of CIR photography and other remote sensor data. At present, compilers are required to identify and outline swamp, submerged swamp, marsh, submerged marsh, and ephemeral lakes and ponds. They do not classify timber as to deciduous or evergreen, but the distinction could be made on the black-and-white panchromatic mapping photographs. Shrubs, evergreen or deciduous trees, and other indicator species are also readily apparent on the mapping photographs. These indicator species may be recognized either on the mapping photographs by the compiler or in the field by the survey party, and would serve, along with other hydrologic identifiers (for example, presence of standing water, water logged soil, absence of leaf litter, and (or) understory) to establish wetland type.

SUMMARY AND CONCLUSIONS

The Geological Survey has prepared three experimental wetland maps for the Auburndale, Florida 1:24,000-scale quadrangle. An experienced compiler used quad-centered high altitude CIR photographs and superwide black-and-white panchromatic photographs to interpret wetland classes and boundaries onto a black-and-white orthophotobase map base made from the CIR.

Three classification systems were tested for possible use by the Geological Survey compilers: the Martin System, the Anderson System, and the Cowardin System. Symbols or codes were devised for each system. The finished maps were compared with standard USGS 1:24,000-scale maps in terms of detail shown and utility of each classification system. The Cowardin System was determined to be the best choice for more detailed Geological Survey topographic maps than are presently produced. The definitions in this system were easiest to apply in the photoidentification process, the density and variety of wetland classes were greater, and the system was open-ended in such a way that the generalized map could be useable on a national basis.

During this study, questions arose as to the best presentation of wetland information. Some possible alternatives for presentation of wetland classes and boundaries in a limited mapping program are mentioned in the discussion section. These include

- The use of existing topographic maps as a cartographic base,
- The use of the orthophoto quadrangle as a wetland base map, and
- Supplying more water regime information on the map itself, or on the map collar.

Any changes in the present method of presenting information on the standard map series would involve some retraining of compilers.

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