The Virginia Wetlands Report

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Wetlands Program

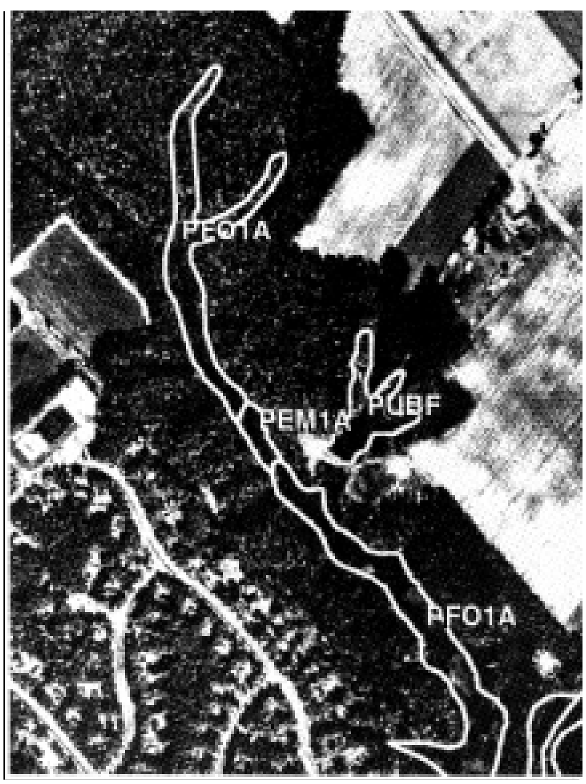
Monitoring Wetlands Status and Trends: The Remote Sensing Solution

Carl Hershner

No net loss of wetland resources is a goal frequently announced by policy makers and resource managers. Most recently, the Chesapeake Bay Executive Council, which includes the Governor of Virginia, reaffirmed its commitment to that goal. Indeed the Executive Council is committed not only to *no net loss*, but also to a long-term goal of a net resource gain. Many people accept these goals, but few understand much about the challenge of measuring progress toward achieving the goals. Knowledge about how many wetlands there are at any given time and what is happening to the resource inventory is commonly identified as *status and trends* information.

Determining the status of the wetlands inventory in Virginia involves measuring the existing complement of all types of wetlands in the Commonwealth, both tidal and nontidal. As most individuals involved in wetlands management can attest, correct identification of wetland boundaries is not a simple matter. Some types of wetland communities, for example winter wet woods, can be very difficult to delineate. Anyone who has spent time attempting to accurately determine the jurisdictional boundaries of a wetland will understand the challenge of trying to inventory all the wetlands of the Commonwealth. To do this with the accuracy required for most regulatory programs would take a massive field effort. Hundreds of well trained specialists working for years still might not be able to complete an inventory of all of Virginia. And if we wanted to know how the resource is changing through time, the field effort would have to be constantly repeated.

The impracticality of a ground-based inventory of all wetlands has led to efforts to find alternative methods for mapping them. At the present time there are basically two options: interpretation of aerial photographs or interpretation of satellite images. Neither is a perfect solution because they each involve tradeoffs between the accuracy of the information developed and the time and money required to generate the information. Both methods are widely used today, but as we will see, only one seems to offer much promise for meeting the goal of monitoring the status and trends of the resource.



Aerial photograph of land area in Gloucester County with wetland areas delineated by National Wetlands Inventory.
PFO=palustrine forested wetlands
PEM=palustrine emergent wetlands
PUB=palustrine unconsolidated wetlands

Aerial Photography

Aerial photography provides the base information used by the U.S. Fish and Wildlife Service's national Wetlands Inventory (NWI). NWI maps are developed manually by trained photo-interpreters. These individuals view photographs taken from very high altitudes at a scale of 1:40,000 (1 inch on the photo is equal to 40,000 inches on the ground, or about 0.6 mile). Using specialized stereoscopic enlargers, technicians draw lines around those areas which appear on the photographs to be wetlands. This effort is facilitated by the use of infra-red photography. The photographs that technicians view are colored according to the amount of heat reflected from objects on the ground. In these photographs vegetation usually appears in various shades of red. Water and dirt generally appear very dark because they tend to absorb heat rather than reflect it. This is useful information because the saturated or inundated conditions in wetlands tend to give them a darker image or signature, than surrounding areas. Experienced photo-interpreters are almost always correct when they decide something is a wetland. The problem is that not all wetlands can be easily detected by this method. The errors which do occur are generally errors of omission—not all wetlands are found.

There are two other characteristics of the aerial photography approach to wetlands inventories that become important in the pursuit of status and trends information. The process can detect fairly small features, but the process can be time consuming. The resolution of the photographic image is such that technicians can generally see things that are at least ten to twelve feet across. This means they can be fairly precise in detecting features like fringing wetlands as long as the signature or image coloring provides the necessary indication of their presence. Attaining this type of precision is not easy or inexpensive. The NWI products are essentially annotated versions of the U.S. Geologic Survey's topographic quadrangles. It takes over 800 maps to cover all of Virginia. The current cost of developing one of these maps as a wetlands inventory can be in excess of $3,000. The process is also time consuming. Virginia and the Chesapeake Bay Program have been working to complete a new mapping of the entire state for the past eight years, and the effort is still not complete.

Satellite Imagery

The other option for inventorying wetlands over large areas involves the use of satellites. While there are increasing numbers and types of satellites available, most wetlands inventory work currently uses the Landsat Thematic Mapper. This satellite carries a multi-spectral sensor which is able to record data in many different parts of the electromagnetic spectrum simultaneously. The result is that there is more information available to the analyst for any particular point on the ground than there is from a photograph. This enables the analyst to detect things which might not be identifiable with just a photograph. The tradeoff, however, is that the satellite image has much lower resolution than the aerial photographs discussed above. The Landsat images portray things on the ground in 30 meter blocks (just under 100 feet). Features which are less than 30 meters across contribute to the information in one block (called a pixel), but cannot be individually distinguished in any image developed from the satellite's information. In other words, a satellite image may be able to find conditions which are not observable in an aerial photograph, but they cannot distinguish small areas.

There are, however, two other characteristics which weigh heavily in the overall utility of satellite imagery for status and trends work. Satellite images cover enormously large areas and can be processed relatively easily. It would take hundreds of high altitude aerial photographs to cover all of Virginia, whereas the entire state will easily fit in fourteen satellite scenes. Processing satellite information is done entirely by computer, making the process relatively rapid and comparatively inexpensive. Field surveys in selected areas are needed to confirm that satellite information has been interpreted correctly, but even with the field work, the approach remains the fastest and least costly option for development of an inventory.

Detecting Trends

Developing a trends analysis from a series of inventories can be tricky business. Once the data has been collected and converted to a computer format, the problems are common to all the types of inventories discussed above (ground based, aerial photographic, or satellite). The basic issue is: *How often do you need an update on the resource?* While there has been much discussion on this subject, most managers and policy analysts have decided that yearly updates are not necessary, but once every ten years is

Continued on page 6

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Roof Thatching: *Phragmites* as a Building Material

Pamela Mason

There has been growing concern over the apparent invasion of North American wetlands by the common reed, *Phragmites australis*. It is generally accepted that there is a link between human impacts to wetlands and *Phragmites* invasion. *Phragmites* is typically found growing in man-made wetlands and in areas of human development. However, in the Delaware Bay and other marsh systems of the Atlantic coast, *Phragmites* is also found growing at elevations preferred by other wetland plants (such as *Spartina cynosuroides*) and in areas that do not appear to have had any direct human impacts. It is the displacement of other wetland species which is the basis for the concern and the cause for the debate over the relative value, both ecologic and economic, of *Phragmites*.

One historic, and current, use of *Phragmites* is as thatching material for roofs. While this use is most common in Europe, it is gaining in popularity in North America. *Phragmites* is called water reed, or common reed, through much of Europe. The use of water reed as a building material is centered around areas of expansive marshlands in England, Ireland, Denmark, Poland and Romania. Originally, most of the reeds used in England were harvested from the Norfolk Broadlands. Today, most of the reeds are harvested from the extensive reed beds of the Danube Delta in Romania.

Only dead *Phragmites* vegetation is harvested to minimize the amount of post-construction shrinkage. The vegetation is tied into bundles of approximately 400 stems. An acre of reed can yield about 400 bundles with a circumference of 24 inches. A bundle of this size will cover about one cubic foot of roof surface. The average roof requires thousands of bundles. There are varied techniques used to attach the bundles to the roof supports. Regardless of the method, thatched roofs are typically 12 to 15 inches thick with a minimum pitch of 45 degrees. A thatched roof will last 20 years, or longer. Thatched roofs insulate better than most other roofing materials.

Newly constructed thatched roof.

Most roof thatchers have learned the art of thatching through an apprenticeship. Several individuals who learned the trade in the British Isles are constructing thatched roofs in the United States. While there seems to be a growing interest in the United States and a renewed interest in the British Isles in the historical craft of aesthetically pleasing thatched roofs, residents of Romania are turning toward more modern roofing materials as thatching is considered to be a symbol of the peasant class.

While harvesting *Phragmites* for building materials may seem to be the perfect solution to what might be called the "*Phragmites* problem" in the United States, little is known of the ecological effects of harvesting in those marsh areas where it is common. For wetland communities where *Phragmites* is the dominant vegetation, and the fish and wildlife communities are dependent on it for habitat, more investigation is needed on the long term effects of harvesting and the potential for sustainable harvesting. We also need a better understanding of the displacement process, its impacts and whether harvesting for thatch may actually promote the spread of *Phragmites* to areas where it is presently not found or exists in small, isolated populations.

Citations

Nevel, B.E., J. Hanganu and C. R. Griffin. 1997. Reed harvesting in the Danube Delta, Romania: is it sustainable? Wildlife Society Bulletin 25(1): 117-124.

Cahill Custom Thatching: http://www.roofthatch.com.

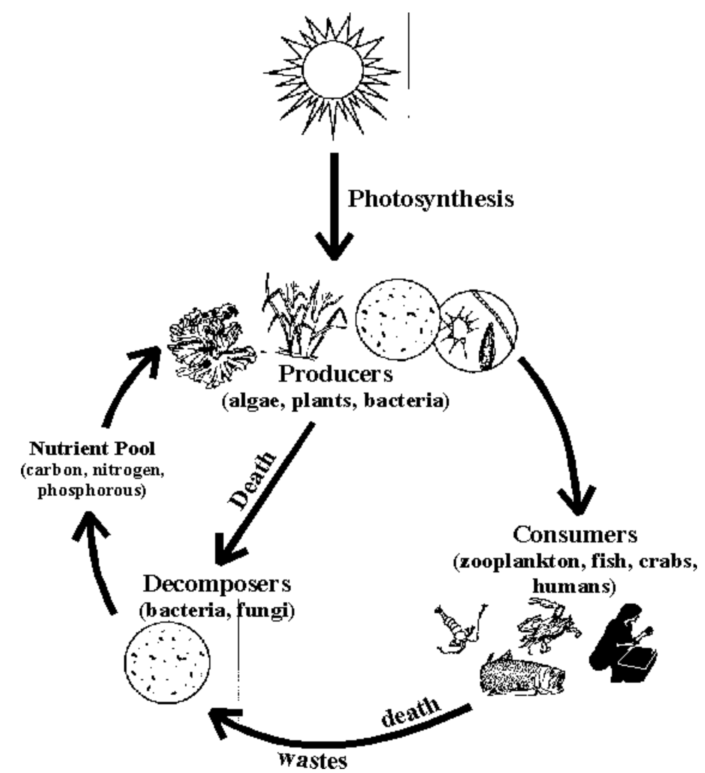
Wondering about Wetlands

William Roberts

Q Are nonvegetated, muddy shorelines valuable to the health of the Chesapeake Bay?

A Many people find it very difficult to believe that a muddy intertidal wetland plays a significant role in the Bay's ecosystem. Intertidal flats are those coastal wetlands characterized by unconsolidated sediments, a lack of standing vegetation and a location between mean high water and mean low water. These unconsolidated sediments are usually composed of sand, mud and organic material, but may also contain gravel or crushed shell.

Understandably, these nonvegetated wetlands are often perceived by the casual observer as unproductive, and therefore unimportant, areas adjacent to vegetated wetlands. While these areas may appear to be non-vegetated because of the absence of the more conspicuous marsh grasses or other emergent plants, in reality these tidal sand and mud wetlands are vegetated with numerous species of algae which function in the recycling of nutrients found in the water. A closer examination will reveal a myriad of creatures and activities on and just below the sediment surface. As many as 300 species of invertebrates can be found burrowing or scurrying about the mud and sand grains. Sampling of 15 square feet of nonvegetated shoreline, the size of the average desk top, can reveal as many as 8300 animals living on, or below the substrate surface! These animals range in size from microscopic organisms to worms almost four feet long!



Organisms living in nonvegetated, intertidal wetlands participate in all parts of the food and energy cycle. There are producers, consumers and decomposers, each playing a vital role in the Chesapeake Bay's ecosystem.

In 1982 the Virginia General Assemble officially recognized the value of intertidal, nonvegetated sand and mud wetlands by amending the Wetlands Act of 1972 to include these nonvegetated wetlands and incorporated them into the Commonwealth's Declared Policy "to preserve the wetlands and to prevent their despoliation and destruction and to accommodate necessary economic development in a manner consistent with wetlands preservation." The Commonwealth's Wetlands Guidelines classify nonvegetated, intertidal sand and mud wetlands as Group Two wetlands types (the same group as saltmeadow hay, big cordgrass and cattails) that warrant a high order of protection.

A basic ecological concept is that energy from the sun provides the initial power source that fuels the Bay's, as well as most, ecosystems. Through the process of photosynthesis, plants and many algae convert sunlight into organic sugar which is used to build plant tissues such as leaves, stems and roots. In this process, essential nutrients like phosphorus, calcium, nitrogen, iron, sulfur and potassium are removed from the surrounding environment and incorporated into the various chemical compounds needed by plants for growth. These plants are then utilized as food by a wide variety of consumers which form the well known food web. As seasons change and the plants die, the important process of decomposition breaks down the plant tissues and releases the nutrients back into the environment to be used again by the producers and eventually by the consumers.

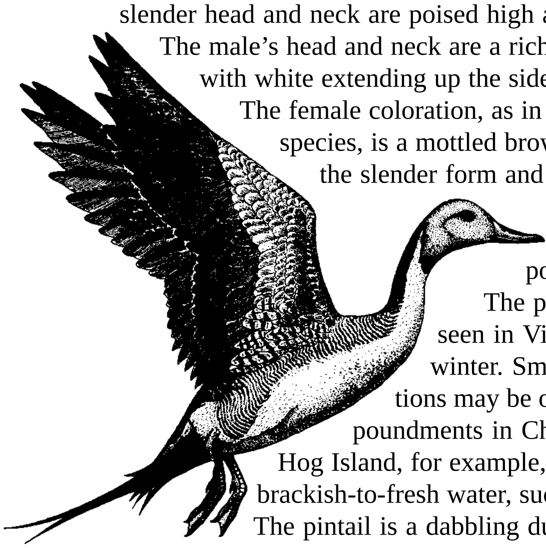
— Feathers & Fins —

Northern Pintail

(Anus acuta)

Julie Bradshaw

The northern pintail is the "epitome of grace and elegance" (Terres, 1980). It is widely distributed and one of the most numerous ducks in the world. In North America, its abundance is probably second only to the mallard's. The pintail is our only freshwater duck with a long tail. In the water, its long tail angles upward, and its slender head and neck are poised high and swan-like. The male's head and neck are a rich brown color, with white extending up the sides of the neck. The female coloration, as in many duck species, is a mottled brown. In flight, the slender form and long tail are distinctive, as are the narrow, pointed wings.



The pintail can be seen in Virginia in the winter. Small congregations may be observed at impoundments in Chincoteague and Hog Island, for example, and on open brackish-to-fresh water, such as Back Bay. The pintail is a dabbling duck, tipping in shallow water to reach its preferred diet of aquatic plant seeds which have settled on the bottom of ponds and marsh surfaces. Other plant parts, such as stems, leaves, and tubers, may also be eaten. Pintails may be seen foraging in grain fields. Some aquatic animals, such as snails, crabs, crayfish, small fish, worms, and insects, are also eaten, particularly by nesting females.

Pintails move northward to their nesting sites early, from January through March. They nest in the prairie pothole region of the northern U.S. and Canada, and in the tundra of Alaska and Canada. Nesting can occur farther away from water than with other ducks, but water and wetlands are required. Nests can be a depression or hollow in the tundra, or, in the prairie region, a typical ground nest is constructed of vegetation and down. In the prairie, nests can be found in meadows, pastures, thickets, brush piles, and similar areas. Incubation lasts approximately 23-25 days, and the young fly 38-52 days after hatching.

Pintails are prized by hunters and birdwatchers. Population size is sensitive to precipitation levels in both breeding and wintering areas. In dry years, population levels fall.

Continued on page 6

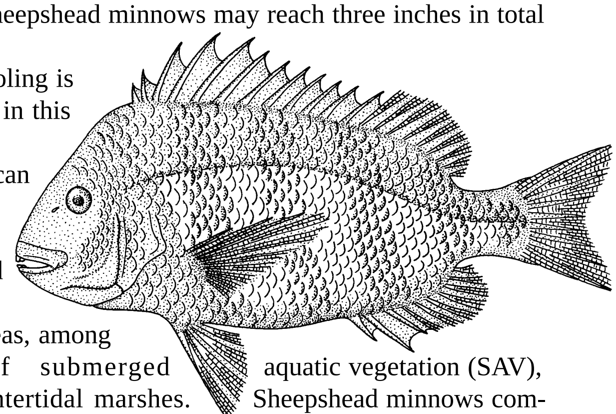
Sheepshead Minnow

(Cyprinodon variegatus)

Lyle Varnell

The sheepshead minnow is commonly found within intertidal and shallow water areas throughout the Chesapeake Bay. It commands an important position in the estuarine food chain and is preyed upon by larger fishes, wading birds and mergansers. It is a member of the family Cyprinodontidae which includes the killifishes and topminnows. Species within this family are commonly used as bait for recreational fishing and also as experimental laboratory animals useful in determining the effects of various chemical agents upon marine life.

C. variegatus may be found in waters of all salinities along the Atlantic and Gulf coasts from Cape Cod to Mexico. Scattered populations have also been found around the islands of the Caribbean. The sheepshead minnow is characterized by a short, deep body with irregular dark bands on the sides. Males are olive above with a steel blue or bluish green area on the back running from the nape to the dorsal fin. Breeding males display orange on their cheeks and lower parts. Males are also distinguished from females by the dark edge on their caudal fin. Females are generally light olive, brown or brassy above with a yellowish to white belly. Sheepshead minnows may reach three inches in total length.



Schooling is common in this species. Schools can observed in non-vegetated shallow water areas, among beds of submerged aquatic vegetation (SAV), and in intertidal marshes. Sheepshead minnows commonly enter marshes during high tides and leave during ebb; but, this species developed an adaptive behavior which helps protect it from larger fish predators found in open water. Rather than exit the intertidal marsh and expose themselves to the open water environment, sheepshead minnows can burrow into the substrate between tidal cycles and wait for the next high tide. The detritus and silt which makes up the substrate provides moisture for the skin and gills, and protection from large temperature fluctuations. Burrowing behavior is also common during the winter. This species may

Continued on page 8

Monitoring Wetlands Status and Trends: The Remote Sensing Solution continued from page 2

not often enough. The practical compromise seems to be about once every five years. This is long enough to detect a significant change but soon enough to respond with changes in management strategy.

The goal of achieving a status and trends analysis of the wetland resources in Virginia and the rest of the Chesapeake Bay watershed, means that implementing an inventory strategy based on satellite imagery is the only practical option. Other approaches cannot produce a comprehensive inventory in the required time, and cannot compete in terms of overall cost. The necessary tradeoff will be in accuracy of the inventory in terms of complete detection of all types of wetlands. The satellite based approach will allow monitoring of distribution, abundance and trends for most types of wetlands, but small features will not be consistently detected and inland forested wetlands will probably be underestimated.

Future Developments

The biggest change in inventory technology will appear in satellite capabilities. Satellites with much higher resolution than Landsat are now on line. Some of the new sensors being launched can detect areas as small as one meter. Others are adding abilities to collect even more information from each pixel. In the near future, satellites will compare well with current aerial photographic capabilities for resolution, and will continue to surpass them in coverage.

Airborne sensors are also continuing to evolve. Some of the more interesting developments include sensors which can *see* through the vegetation canopy to detect soil moisture conditions. This technology has tremendous potential for enhancing the accuracy of remotely sensed wetland inventories.

In the immediate future, VIMS expects to be working on methods for combining different types of information in order to enhance inventory accuracy. Currently we are working on applications of an airborne, digital, multi-spectral video camera as a *ground-truthing* tool for classified satellite imagery. We are also testing protocols for field surveys using global positioning system (GPS) equipment as a means of adding information to shoreline and wetland surveys developed from satellite images.

The need for synoptic information on natural resources and human impacts over very large areas, means an increasing reliance on remotely sensed data. The wetlands status and trends issue is an excellent example of the advantages and limitations of options facing managers.

Additional Satellite Image Information

Mission to Planet Earth
http://www.hq.nasa.gov/office/mtpe/

National Wetland Inventory
hyyp://www.nwi.fws.gov/

EOSAT - Landsat
http://www.eosat.com

Global Land Information System
http://wsww.edcwww.cr.usgs.gov/webglis/glisbin/glismain.pl

ORBIMAGE
http://www.orbimage.com/

Northern Pintail continued from page 5

Habitat loss and degradation, and conflict with agriculture provide additional threats to pintail populations. They seem to have benefitted from habitat creation and preservation efforts such as the North American Waterfowl Management Plan. If the protection, restoration and enhancement of such wetland habitat continues, the survival of significant pintail populations should be ensured and along with this mankind's enjoyment of these exquisite birds.

References:

Fredrickson, Leigh H. & Mickey E. Heitmeyer. 1991. Life History Strategies and Habitat Needs of the Northern Pintail. U.S.F.&W.S. Leaflet 13.1.3, Waterfowl Mgmt Handbook. 8 pp.

Suchy, Willie J., & Stanley H. Anderson. 1987. Habitat Suitability Index Models: Northern Pintail. USF&WS. Biological Report 82(10.145). 23 pp.

Terres, John K. 1980. *The Audubon Society Encyclopedia of North American Birds.* Alfred A. Knopf. NY. 1109 pp.

Illustration courtesy of Fish & Wildlife Service.

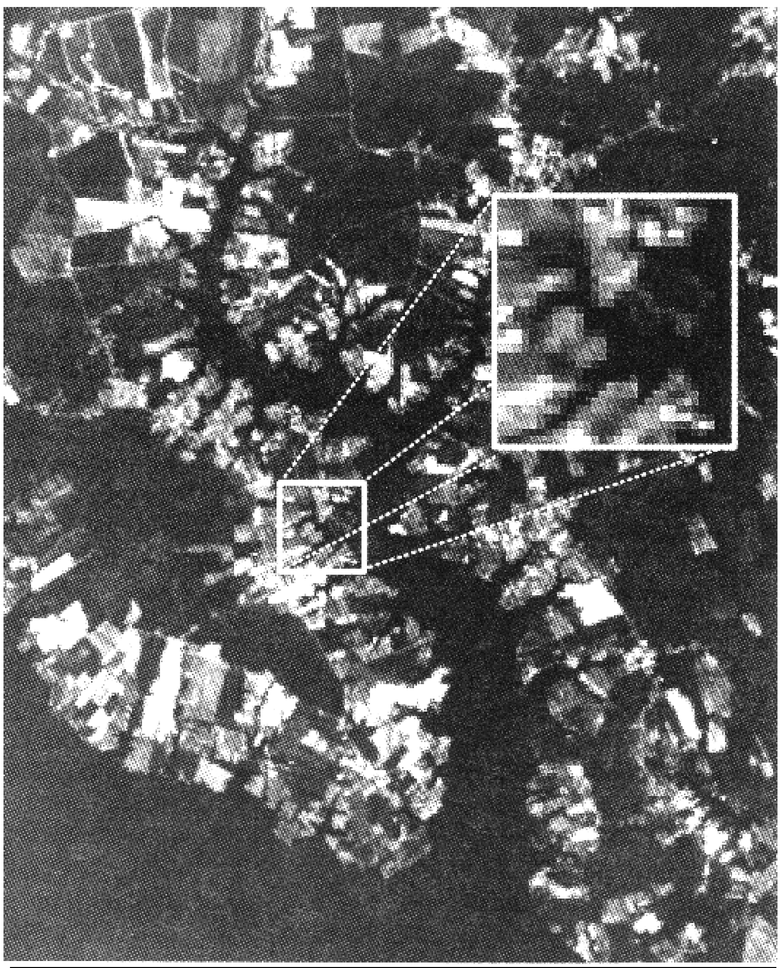
Classifying Satellite Imagery To Detect Land Cover Features

Marcia Berman

Satellite imagery has been used extensively to describe and monitor characteristics of the earth's surface and how these characteristics change over time. Although much of the technology was developed for national security and defense purposes, over the last decade successful applications have evolved for resource management and land use planning.

The cover story briefly discusses the opportunity that Landsat satellite imagery offers for mapping wetlands today and in the future. The Comprehensive Coastal Inventory Program at VIMS has compared this remote sensing tool with higher resolution products like aerial photography to evaluate the accuracy and precision with which we can map wetlands from satellite imagery. The results are very promising.

Few people understand the process used to convert satellite data into an image of the earth's surface. Satellite data is basically a digital picture of the earth's surface which has been ortho-corrected and stored on a compact disc. Orthocorrection is the process which gives the image geographic coordinates, and allows it to be used as a map. The picture itself doesn't have a legend with a series of categories or classes identifying the location of various features such as wetlands. This step is accomplished through a lengthy, technical analysis called *image processing.* Image processing uses the data in the digital image to build the classification. In the case of the Landsat Thematic Mapper each snapshot of the earth's surface actually generates seven different digital pictures, each one representing the information in a different, part of the electromagnetic spectrum. An image processing specialist will choose which one of several of the data sets reliably detect a particular feature on the earth's surface, such as a tidal wetland. Once this pattern has been identified, the computer can then be instructed to find all other parts of the scene in which that particular pattern of the data sets is also found. All of these areas are then classified as tidal wetlands.



Landsat image of East River in Mathews County, Virginia, with enlarged section to demonstrate 30m x 30m pixels.

Processing satellite imagery requires a very patient and competent technician. Ideally, the individual should be skilled in both remote sensing and landscape ecology so the classification can be continually evaluated during development. Image processing also requires fairly sophisticated software, running on very robust computers. The size of the data files and the complexity of the data put significant demands on the memory and computational capacity of the system. Finally, producing a useful final image requires a

Continued on page 8

Calendar of Upcoming Events

June 8-12, 1998 **Society of Wetlands Scientists Annual Meeting**
Anchorage, Alaska. Contact Terry Brock: tbrock@ptialaska.net

July 12-15, 1998 **The Coastal Society Biennial Meeting**
Minding the Coast: "It's Everybody's Business"
Williamsburg, Virginia. Contact Mo Lynch, Conference Chairman, at (804) 684-7151 or email: tcs16@vims.edu

Sept. 28-30, 1998 **International Conference of the Society for Ecological Restoration**
Austin, Texas. Abstracts to http://www.phil.unt.edu/ser/call.htm or stevew@jove.acs.unt.edu. For information contact the Society at: (608) 262-9547 or email: ser@vms.macc.wisc.edu

Classifying Satellite Imagery
To Detect Land Cover Features
continued from page 7

classification system which groups landscape features in meaningful and appropriate ways.

A variety of classification schemes currently exist which can be easily applied to satellite imagery. Choosing a particular scheme, or designing a new one, should be directed by the intended use for the information. For example, foresters may wish to have many different types of forests identified, and be satisfied with a scheme which lumps everything else on the face of the earth into a classification of *other*. The most widely used classification is the Anderson classification, a hierarchical system that classifies all components of the landscape based on use and/or cover type. Natural resource managers have found this classification particularly useful because the hierarchical approach permits expansion or increased resolution in those classes of greatest interest.

Variations of the Anderson classification have been developed by programs within NOAA, EPA, and USGS. They each differ from the original in their attempts to focus on one or more landscape elements. For example, NOAA's Coastal Change Analysis Program (CCAP) revised their classification to group all forested areas into four categories: deciduous, evergreen, mixed, and palustrine. In contrast, the Chesapeake Bay Program chose to group forested areas into only two categories: woody and woody urban. Wetlands are grouped by the Chesapeake Bay Program into one category known as herbaceous wetlands. NOAA/CCAP elected to distinguish among estuarine emergent, palustrine emergent, palustrine forest, and scrub/shrub wetlands.

The ability to apply either of these classification systems to an image depends on the base data's spatial resolution and ability to support fine distinctions. As indicated in the cover article, Landsat imagery can currently resolve features in the landscape that are larger than a 30m x 30m pixel. The Anderson, NOAA-CCAP, and Chesapeake Bay Program classifications have all been successfully applied to Landsat scenes. As the resolution of satellite products increases, it should be possible to move deeper into the Anderson classification and classify landscapes in ever greater detail.

Sheepshead Minnow
continued from page 5

also migrate into deeper estuarine waters during the colder months.

Spawning occurs during the spring and summer in shallow nearshore waters over sand or silt. The eggs of *C. variegatus* are demersal and adhesive, and may stick to plant matter, debris or each other. Males stake out a territory generally less than one meter in diameter around the eggs and may even dig nest pits within this area to house the eggs. Eggs hatch usually within four to eight days. Yolk sac larvae, larvae and juveniles prefer shallow sandy and silt bottoms within vegetated areas for development. Maturity is reached at four months to one year. At maturity, males are generally about 25 millimeters long and females are slightly larger at 28 millimeters in length.

Sheepshead minnows are detritovores. They prefer to forage over thick substrates of silt and detritus. Although feeding primarily on plant detritus, small crustaceans have also been documented as a part of their diet.

The sheepshead minnow is a resident wetland species in the Chesapeake Bay and other Atlantic and Gulf coast estuaries. It occupies a critical position in the ecology of these areas. Estuarine wetlands produce large amounts of organic matter that only certain key species can consume and directly use as food. *C. variegatus* is one of these key species which transforms detritus into usable food material for the larger Bay species of recreational and commercial importance.