

# ***The Virginia***

# ***Wetlands Report***

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## **An Introduction to Stressed Habitats**

*James E. Perry, John E. Anderson and Arnold F. Theisen*

**M**uch scientific attention is currently being paid to temporal and spatial changes in the Earth's ecosystems. This particularly holds true for changes induced by some specific byproducts of human society, such as water and air pollution, global warming, and depletion of the atmospheric ozone layer. The effects of these byproducts on an ecosystem is usually observed as a "stress" to the indigenous biotic communities (Table 1) and can result in significant changes in the function and value of an ecosystem (e.g. the decline of the oyster from Chesapeake Bay). Therefore, it is important that we are able to rapidly identify, monitor, and, hopefully, manage for stress induced changes in an ecosystem. Equally important is that we understand and identify the long term impacts that an individual or group of stresses may have on ecosystem processes. Remote sensing techniques now provide us with the ability to monitor temporal and large spatial scale changes in an ecosystem's physical, chemical, and/or biological patterns. By correlating remotely sensed data with ecological field data of a site, we should be better able to monitor and determine the role stress plays in modifying the overall attributes of that site.

Current efforts to study stresses involve trying to understand the

mechanisms of the stress as well as finding ways to quantify and monitor the changes that a specific stress brings to the ecosystem. This is the first of a series of articles designed to

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**Habitat** is an elastic term that is usually used to denote a rather specific kind of living space or environment, i.e. a constellation of interacting biological, chemical, and physical factors that provide at least minimum living conditions for a single organism or a group of species.

**Community**, on the other hand, is a complex aggregation of plants and animals (Daubenmire 1968). For example, a salt marsh is a saline tidal **habitat** comprised of a plant **community** that is dominated by smooth cordgrass and an animal community dominated by euryhaline fish and highly motile birds and mammals.

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introduce the concepts of "stressed habitats and communities" and the tools and methods that VIMS is employing to study them.

Webster's New World Dictionary (1990) defines stress as the force exerted on a body that tends to strain or deform its shape. When used in the context of an ecosystem, the term stress implies a change in an environmental parameter, either biological, chemical, or physical, to a less friendly form which will then place a strain on the biota of the ecosystem (Table 1). Stress can lead to a reduction of

growth, yield, value, or even death of some or many components of the ecosystem. It is highly unlikely that all of the environmental parameters of an ecosystem will always function at their optimal level. Therefore, the concept of zero stress—the optimum growth conditions of a habitat—is only theoretical. Even in the most minimally disturbed areas there is always a small amount of stress exerted on all habitats. It is when these stresses change (either by a dramatic increase or decrease) that, using analytical remote sensing methods, detection becomes possible. Throughout the rest of this article, stress will be referred to as a change in the pressure on an ecosystem exerted through environmental and/or anthropogenic (i.e. human induced) mechanisms.

Animal and plant communities usually respond differently to stress. While animals are generally mobile and tend to migrate away from stress, non-motile plant communities must either adapt (if it is long term), or survive until it abates. Since the purpose of this manuscript is to discuss measuring stress at a habitat/community level, we will need to use the spatial and spectral structure of the habitat/community as an indicator. Therefore, we will emphasize the use of remote sensing to measure stress in plant communities.

## How We Measure Stress

Spectral reflectance (i.e. the amount of light a plant absorbs at specific wavelengths) is unique to an individual plant species (Figure 1) and can be easily measured in the field. (We will discuss how we do the measurements in future articles.) Under optimum environmental conditions a plant operates at a high efficiency level. Light absorption (due to chlorophyll pigments) is maximized in the blue

and red regions of the visible light spectrum. However, when an environmental parameter falls below optimum (e.g. amount of water, nutrients, toxic exposure), a plant is stressed and its efficiency and, therefore its absorption, drops. This can change the amount of energy absorbed (or reflected) by the plant in specific wavelengths of light and, consequently, the shape of the spectral reflectance curve as well. Therefore, by measuring the difference in the absorption and reflectance of light used by the plant under different

ing. It is also difficult to determine which parameters are important to measure and how to correctly make the measurements. A second option is to grow plants under known environmental conditions, usually in a greenhouse. This option, although it allows control over most environmental conditions, has been criticized as not being truly representative of real field conditions (i.e. it does not allow the inherent interactions characteristic of an ecosystem). Therefore, whichever option is selected, we must have a thorough

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*Table 1. Sources of environmental stress (modified from Hale and Orcutt 1987).*

| Physical    | Chemical              | Biological       |
|-------------|-----------------------|------------------|
| Drought     | Air Pollution         | Competition      |
| Hydroperiod | Toxins                | Human activities |
| Temperature | Nutrient availability | Diseases         |
| Radiation   | Pesticides            | Insects          |
| Mechanical  | Salinity              | Grazing          |
| Electrical  | Soil pH               |                  |
| Magnetic    |                       |                  |
| Wind        |                       |                  |

environmental conditions we can measure and quantify the reactions of the plant to a given stress (Figure 2). There are many remote sensing instruments that we can use to measure these differences (e.g. radiometers, spectrophotometers, multispectral and hyperspectral scanners). We will discuss some of these in detail in future articles.

## Environmental Parameters of Plant Stress

In order to confidently interpret remotely sensed data, we first need to collect the data under known environmental conditions. Here we have two options. First, we can physically collect the field data on site. This necessitates a study design that identifies and quantifies critical environmental parameters of a project site, such as soil chemistry, hydroperiod, and vegetation structure, for correlation with the remotely sensed data. This option is usually expensive and time consum-

ing. It is also difficult to determine which parameters are important to measure and how to correctly make the measurements. A second option is to grow plants under known environmental conditions, usually in a greenhouse. This option, although it allows control over most environmental conditions, has been criticized as not being truly representative of real field conditions (i.e. it does not allow the inherent interactions characteristic of an ecosystem). Therefore, whichever option is selected, we must have a thorough

understanding of the shortcomings of each option. We can minimize the effects of the problems by having a well defined set of goals and objectives for the field work. This should be preceded by a thorough literature review to identify the important environmental parameters and recommended methods for measuring specific parameters for the site under study. At VIMS' Coastal Ecosystems and Remote Sensing Program (CERSP), remote sensing is being validated by vigorous field work to measure the spectral and spatial attributes of stress on wetland communities. We are working on both tidal and non-tidal systems to develop relationships between the spectral detectable manifestations of stress on wetland plants and the relationship of these signatures to physical, chemical, and biological parameters. These data are combined with spectral imagery so that synoptic analyses can be performed, allowing stress and environmental parameters to be measured at the community level.

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# — Feathers & Fins —

## Wood Duck

*Aix sponsa*

Julie Bradshaw

The wood duck is one of the most colorful ducks native to North America. The male, or drake, has a dark iridescent head with white striping, a “swept back” crest, white throat, orange-red eyes, bill with red, yellow, black, and white. The female is much less brightly colored than the male, but is nevertheless distinctive with its large white eye patch.

The wood duck gets its common name from the forested habitat in which it is usually found. It generally inhabits swamps, wooded floodplains, and woodlands around lakes, ponds, and streams. The wood duck spends more time out of the water than other ducks, often walking well into the woods in search of food. Accordingly, it is more skilled at walking and running on land than other duck species.

The wood duck is a medium sized dabbling duck. The majority of its food is plant material, but animals also make up an important part of their diet. Wood ducks generally forage on land or in water of depths up to approximately 1.5

feet. Vegetation eaten includes floating duckweed, and seeds and tubers of many aquatic and wetland plants. The wood duck also travels

away from the water into the woods in search of acorns, hickory nuts, berries, and grapes. Gleaning

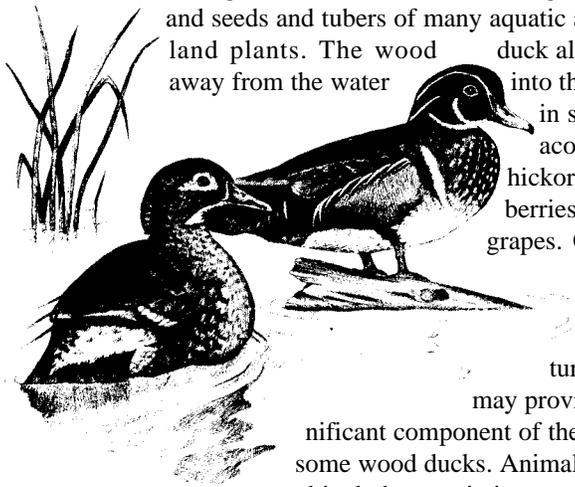
harvested agricultural fields

may provide a significant component of the diet of

some wood ducks. Animals consumed include aquatic insects, minnows, frogs, tadpoles, snails, and small salamanders.

Wood ducks are migratory, but may be seen in Virginia year-round, particularly in the coastal plain. Wood ducks do not usually gather in large flocks or associate with other species. Small family groups of 15-20 ducks may travel together in migration. In fall and winter large groups may roost together, but they generally disperse into the smaller groups for daily foraging.

Wood ducks nest in cavities of trees existing in or near water or a mile or more away from the nearest water. The



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## Striped Killifish

*Fundulus majalis*

Lyle Varnell

The striped killifish is an important contributor to the estuarine food chain, and is commonly found in shallow water areas and intertidal wetlands throughout the Chesapeake Bay. It is a member of the family Cyprinodontidae which includes minnows (such as the sheepshead minnow, *Virginia Wetlands Report*, Volume 13, Number 1, Winter 1998), mummichogs and other killifishes. Species within

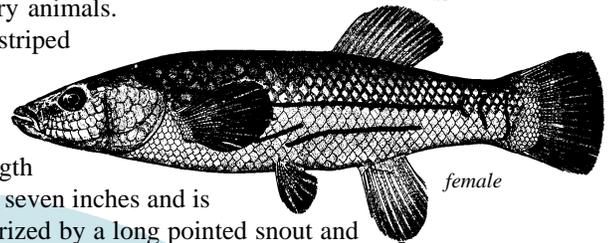
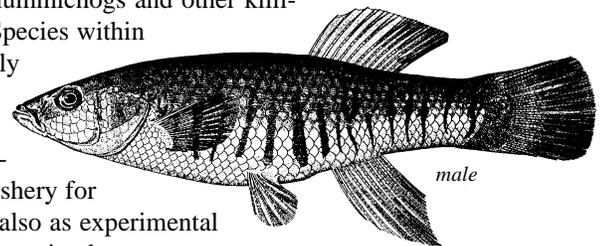
this family are valued in the recreational fishery for bait and also as experimental laboratory animals.

The striped killifish may reach a total length

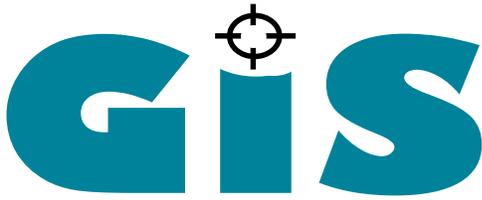
of about seven inches and is characterized by a long pointed snout and 14-15 dorsal fin rays. Body markings are quite different between the sexes with males displaying 15-20 dark vertical bars on the sides, whereas females have 2-3 longitudinal black stripes. Gulf coast female striped killifishes may also display dark vertical bars, but in numbers much fewer than for males. *F. majalis*' geographic range extends along the Atlantic and Gulf coasts from New Hampshire to northern Florida.

Striped killifish prefer to move in schools in vegetated and nonvegetated intertidal wetlands and adjacent shallow water areas. It is common for this species to enter marshes during high tides and leave during ebb. Like other members of the Cyprinodontidae, *F. majalis* inhabits deeper estuarine waters during the colder months, or may burrow into the substrate in intertidal areas between high tides. The fish is protected from moisture loss and temperature stress by the thick silt and detritus substrate.

Spawning occurs from about April through September in the Chesapeake Bay in nearshore waters which are not subjected to stress from wave energy. The eggs of *F. majalis* are buried in the substrate, either passively by tides and currents or actively by the parents. Larval and juvenile stages develop primarily in vegetated nearshore and intertidal areas



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# Geographic Information System

## An Update on the Virginia Geographic Information Network

Marcia R. Berman

Several issues ago, the prospect of a well developed Virginia Geographic Information Network (VGIN) seemed dismal. VGIN was re-instituted by the legislature during the 1997 General Assembly (Code 2.1-563.36-41). A division within the Council on Information Management, VGIN reports to an Advisory Board, which includes a Planning Committee and a Policy and Standards Committee. Members on these committees span political appointments, state agency information users, members from the Virginia Geographic Information System (GIS) Users Group, and private sector industry. Despite the recognized need for VGIN, little if any monies were appropriated to activate VGIN beyond a mere vision. With funding support from the Virginia Department of Transportation (VDOT) and the Virginia Economic Development Partnership (VEDP), the prospect once again is invigorated.

VGIN has several missions. Among them is to oversee the development of policies to proffer the acquisition, and exchange of geographic data

to support state and local government. Improving access to geographic data is also a key issue for VGIN, as is cataloguing existing data maintained by state and local agencies. In earlier efforts, VGIN has identified new data layers for state-wide coverage. This effort is expected to continue with an initial focus to prioritize geographic data layers for procurement.

The Policy and Standards Committee works to develop guidelines for VGIN. The committee has interests from both the state and private sectors represented. A technical board, composed mainly of GIS users around the state, guides this committee in technical areas. Discussions within these meetings have been fueled by the data needs across state agencies and local governments. Standards related to data format, quality control, and metadata are all issues which must be resolved. While standards must be imposed, the committee is sensitive to placing restrictions that might discourage a potential group or agency from contributing to a state-wide data network to improve data access and ex-

change. This network is likely to be rooted in the World Wide Web. Several surveys have been initiated to gather potential data sources throughout the state. The VEDP has been very instrumental in this.

While an active "Network" is still a vision, VGIN now has a coordinator in Mr. Bill Shinar. Mr. Shinar has accepted a position with the Commonwealth of Virginia to coordinate activities of VGIN. His previous accomplishments include the design and development of South Carolina's statewide Economic Development GIS. Prior to that, at the University of Georgia, he served as the Director of the GIS and Economic Development Program under the Vice President for Services. Most recently, Mr. Shinar worked in the private sector, where his clients ranged from public service and utility companies to state natural resource agencies. His achievements demonstrate a broad based knowledge in information management among government agencies and private industry. This should prepare him for the unique challenge he faces in Virginia.

### Wood Duck

*continued from page 3*

nest cavity may range from 5 to 50 feet above the ground. The female uses its own down feathers for nesting material. Eggs (usually 10-12) are incubated by the female for approximately one month. The young birds have sharp claws with which they can climb out of the nest. They then jump to the ground, following the mother's calls, and are led to the nearest water. The young are able to fly approximately two months after hatching. In Virginia, young are seen from March through August.

Wood duck populations were dangerously low in the early 1900's, due to overhunting, forest clearing, and draining of swamps. The United States and Canada closed hunt-

ing seasons for the species from 1918-1941. Populations have recovered, but remain threatened by continuing habitat loss. Artificial nest boxes appear to have aided in population recovery. Preservation of bottomland swamps, floodplain forests, and forested buffers around waterways are crucial to maintaining this striking duck of the woods.

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*Artwork courtesy of U.S. Fish & Wildlife Service.*

# Wondering about Wetlands

William Roberts

**Q** What is riprap? Is it preferred over a bulkhead for shoreline erosion control?

**A** The term riprap denotes any type of broken material that can be used to create a structure. Riprap comes in all shapes and sizes and is made from so many types of material that a simple definition is rather elusive. The term riprap can refer to various unsuitable broken or crushed material but most often refers to broken concrete or by far the most common form, various grades of granite stone. Riprap is generally used in conjunction with the term revetment and together they are used to denote a structure composed of broken or rubble material. A more concise way to define these two terms is to say that “revetment” refers to the structure itself, and the term “riprap” refers to the type of material used to form the structure. Occasionally, other materials as mentioned above can be used to construct the revetment. So, we can have a riprap re-

vetment composed of clean, properly sized pieces of highway concrete. In addition, riprap in the form of smaller-sized, granite stone, is frequently used to fill and stabilize off-shore gabion design breakwaters. As with any marine structure, proper design utilizing appropriately sized materials that are correctly installed, is essential for long term use and life span in the aquatic environment.

In order to answer the second question we must first look at it from two perspectives: the environmental perspective and the cost-effective perspective. From the environmental perspective, the use of a riprap revetment in place of a bulkhead is preferable for several reasons.

First, riprap revetments can and do act as habitat for many marine organisms. When the riprap revetment is constructed in the intertidal zone the spaces between the indi-

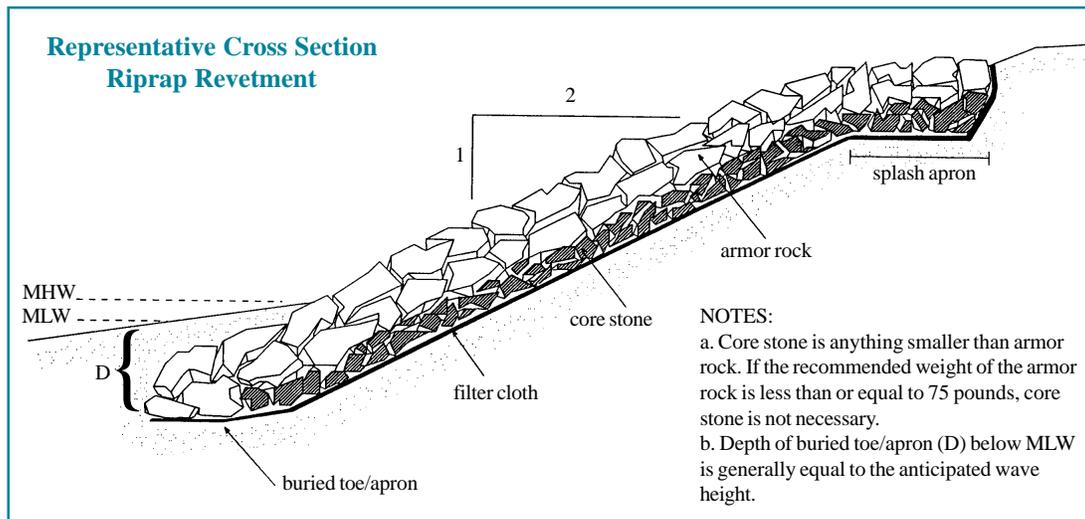
vidual rocks provide places for small marine organisms to hide from predators and the many surfaces of each rock provide a place of attachment for microscopic algae, various seaweeds, shellfish and other invertebrates. As a rule, bulkheads constructed of pressure treated wood do not provide habitat for marine organisms because they are pressure treated with toxic chemicals to prevent decomposition of the wood by marine organisms and indeed do allow the toxic agents to leach to the surface of the wood to prevent marine growth. One notable exception is a bulkhead made of vinyl or recycled plastic. This type of bulkhead is not treated with toxic metals since marine organisms will not decompose PVC.

Second, the rough surface and slope of a riprap revetment act to dissipate the force of waves as they move land-

ward. This process of dissipation reduces the erosion potential of the waves as they strike the revetment and reduces the tendency for wave energy to be transferred to other, un-

protected shorelines. Occasionally, wetland vegetation will begin to grow in front of a riprap revetment if sufficient sunlight is available and the elevation (water depth) is correct. Bulkheads, on the other hand, do not absorb wave energy. In fact, bulkheads reflect the energy of the incoming waves and transfer that energy to nearby areas, often increasing erosion potential. Except in the most protected areas, rarely will wetland vegetation be found channelward of a bulkhead because the reflected wave energy tends to scour the sand, soil and plants away. Often a riprap revetment must be placed in front of the bulkhead to prevent scouring of the bulkhead toe (base).

Third, riprap revetments constructed of granite rock or clean concrete are inert in that there are no potentially



Continued on page 8

## Conclusions

Our ability to detect temporal and spatial changes in the natural environment is improving as new remote sensing tools are developed. This is an important step in better defining the state of our natural resources. However, in order to be able to predict future changes, we need to further quantify and define the relationship between the changes in the remotely sensed data and changing environmental conditions.

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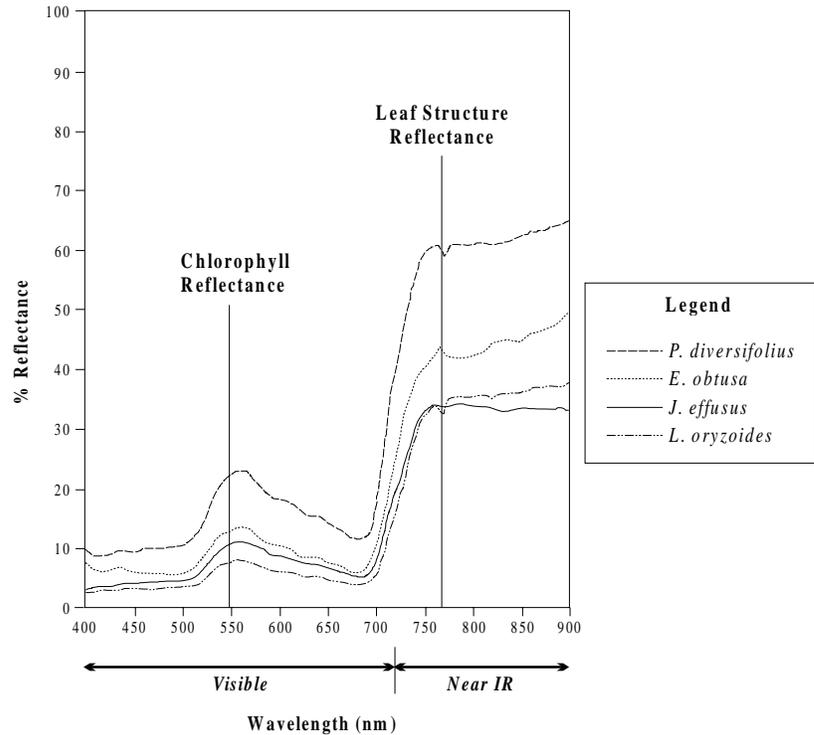
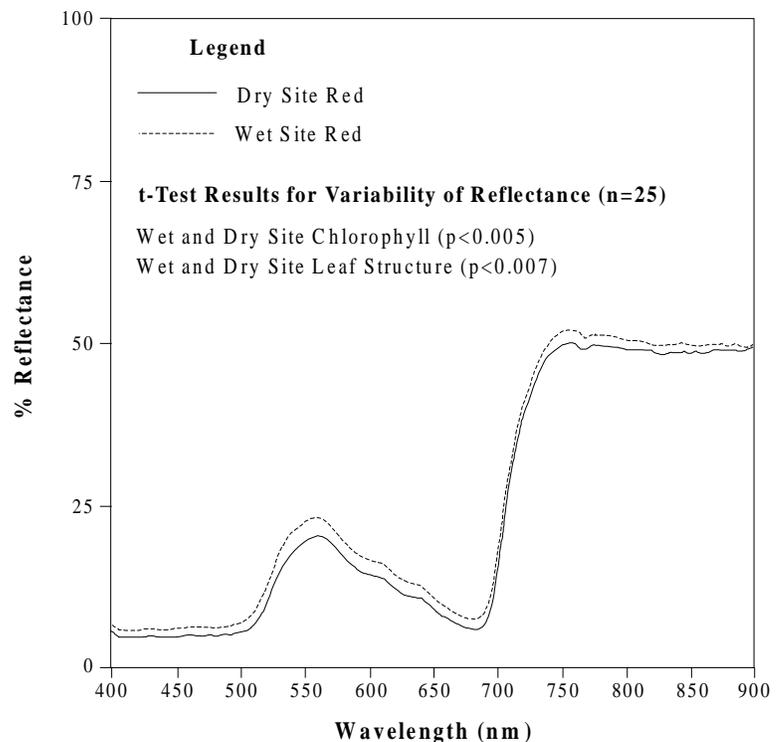


Figure 1. Spectral reflectance measurements for spike rush (*Eleocharis obtusa* Willd.), soft rush (*Juncus effusus* L.), rice cut-grass (*Leersia oryzoides* L.), and pondweed (*Potamogeton diversifolius* Raf.) under near optimal conditions. Spectral curves are unique to each species and vary with the addition of any stress (also see Figure 2). Data were taken with a hand held radiometer. Figures from Anderson and Perry (1996).

Figure 2. Average leaf spectral reflectance measurement for *Acer rubrum* (red maple) collected on two sites with different water levels. The wet site represents a "stress" condition. The *p* values in the figure indicate that the two sets of data were significantly different. Figure from Anderson and Perry, 1996.





## Wild Rice

Pamela Mason

**W**ild rice is not a true rice of the genus *Oryza* (see Wetlands Report Volume 10 issue 2, 1995). However, wild rice historically served as an important food for Native Americans and continues to be an important food for humans and wildlife.

Wild rice is native to North America ranging from Nova Scotia to Manitoba and south to Louisiana and Florida. It grows in fresh or low salinity brackish marshes and can be found along streams in both tidal and nontidal waters. The greatest natural populations of wild rice are found around the Great Lakes and the upper Mississippi River valley. In Virginia, two species of wild rice are found, Northern Wild Rice (*Zizania aquatica*) and Southern Wild Rice (*Zizaniopsis miliacea*). The largest populations of wild rice are found on the Pamunkey, Mattaponi and upper Rappahannock Rivers. Northern Wild Rice is the predominant wild rice in Virginia marshes.

Wild rice grains are difficult to collect because the inflorescences shatter upon contact, scattering the grain. This poses a problem for efficient harvesting, as much of the grain is scattered during

harvest. Historical accounts describe the traditional method used by Native Americans for collecting wild rice. Using canoes, they worked through the dense stands of *Zizania*. The grains were collected by bending the rice over the canoe and beating the plants allowing the grain to fall into the boat. This method has not been dramatically improved upon and is still used today.

Wild rice cultivation in the United States began only recently, around 1960 (Simpson & Ogorzaly, 1986). Plant breeders have produced a nonshattering strain of rice increasing production from 100 to 700 pounds per acre. Cultivated rice can be harvested by combines equipped with oversized wheels. There appears to be a high demand for wild rice, and while cultivation efforts are likely to expand in an effort to meet the demand, Native Americans employing the traditional method remain a primary source for wild rice.

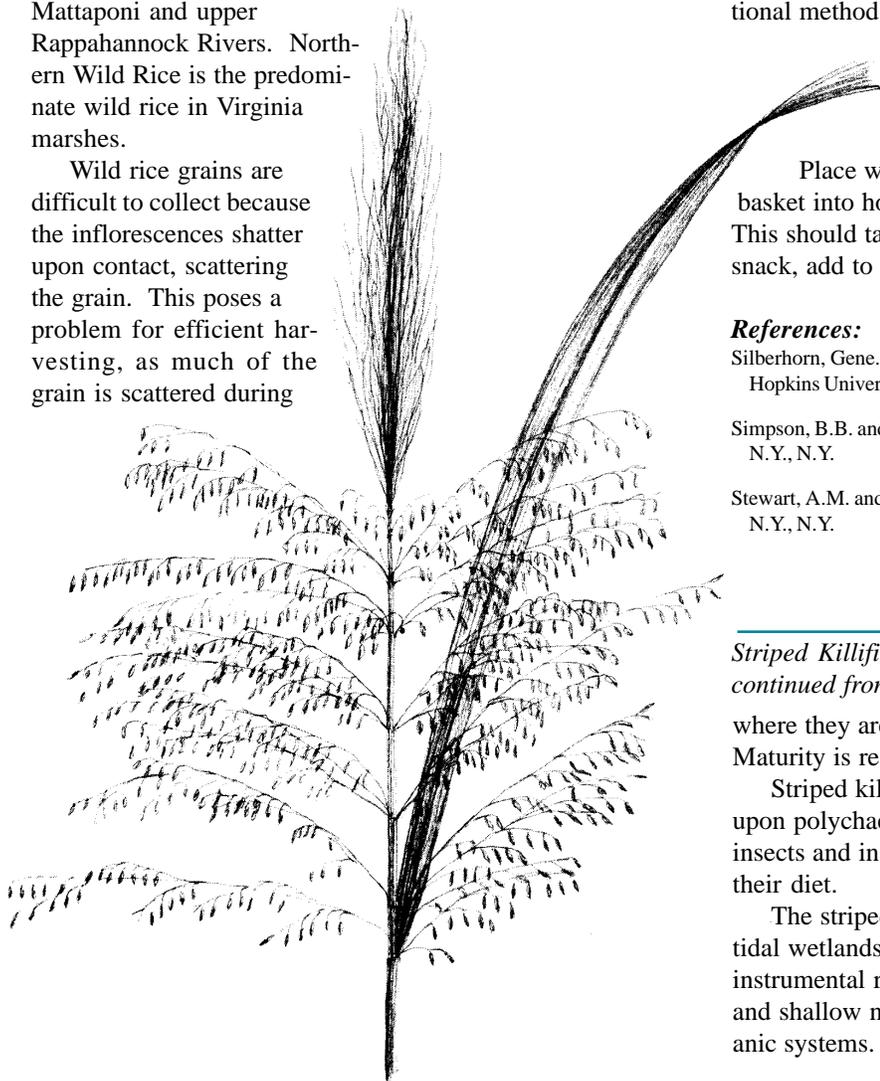
For a simple and fun way to prepare wild rice, you might try the following:

### Fried Wild Rice

Place wild rice in a fine mesh frying basket. Lower the basket into hot oil and fry until the grains start to pop open. This should take about 3 minutes. Lightly salt and eat as a snack, add to salads, or garnish vegetables.

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### Striped Killifish

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where they are afforded the most protection from predators. Maturity is reached during the second year.

Striped killifishes are opportunistic feeders which prey upon polychaetes, small crustaceans and mollusks, and even insects and insect larvae. Detritus is also a major part of their diet.

The striped killifish is an important resident species of tidal wetlands throughout its geographic range. It plays an instrumental role in the energy flow from intertidal marshes and shallow nearshore areas to the larger estuarine and oceanic systems.

# ***Calendar of Upcoming Events***

- July 29-31, 1998** **Ecosystem Restoration: A National Symposium to Bring Together Ecosystem Restoration Practitioners and Researchers.**  
Contact: EPA at 1-800-783-3870
- 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 [stevev@jove.acs.unt.edu](mailto:stevev@jove.acs.unt.edu). For information contact the Society at: (608) 262-9547 or email: [ser@vms.macc.wisc.edu](mailto:ser@vms.macc.wisc.edu)
- Nov. 4-6, 1998** **Wetlands Regulatory Workshop**  
Holiday Inn on the Boardwalk, Atlantic City, NJ. Contact: Ralph Spagnolo, EPA, at (215) 566-2718 or email: [spagnolo.ralph@epamail.epa.gov](mailto:spagnolo.ralph@epamail.epa.gov)
- June 6-12, 1999** **Society of Wetland Scientists Annual Meeting, Norfolk, Virginia**  
Contact: Harold Jones at (757) 441-7777 or email: [harold.r.jones@usace.army.mil](mailto:harold.r.jones@usace.army.mil). Also see the SWS South Atlantic Chapter homepage: <http://www.sws.org/regional/southatlantic/>
- July 24-30, 1999** **Coastal Zone 99, San Diego, CA. Call for Papers. Abstracts due August 1, 1998.**  
Contact Martin C. Miller, USACE Waterways Experiment Station at (601) 634-3999 or email: [m.miller@cerc.wes.army.mil](mailto:m.miller@cerc.wes.army.mil)

## *Wondering About Wetlands continued from page 5*

harmful toxins to leach out into the surrounding water. In general, asphalt should not be used and any exposed rebar should be removed for safety purposes.

From the cost-effective perspective a riprap revetment may be preferred for several reasons: First, when properly designed to meet the identical conditions, a riprap revetment is generally equal to or less expensive than a bulkhead constructed of pressure treated wood and normally less expensive than a bulkhead constructed of vinyl or recycled plastic. Second, the old adage "rock is forever" applies to riprap. A properly designed and constructed (granite stone) riprap revetment will last indefinitely. In comparison, a pressure-treated wooden bulkhead will last generally from 10 to 20 years. Because vinyl or recycled plastic bulkheads are new, very little information exists on their expected longevity. While vinyl is not subject to decay caused by marine organisms, its ability to withstand frequent storms or resist deterioration due to sunlight remains unknown.

For additional information about riprap revetments including their design, construction and application in shoreline erosion protection, please refer to articles by Walter Priest in the Spring 1993 (93-4) and William Roberts in the Summer 1997 (12-2) issues of *The Virginia Wetlands Report* available from the Wetlands Program at VIMS, (804) 684-7380 or the Shoreline Development Best Management Practices booklet available from the Virginia Marine Resources Commission, 2600 Washington Avenue, Newport News, VA. 23607.

**Editor's Note:** In the previous issue of the *Virginia Wetlands Report*, Vol. 13, No., 1, the incorrect species of fish was shown for the Sheepshead Minnow. Below is the correct species.

