Summer 7-1-1991

The Virginia Wetlands Report, Vol. VI, No. 1

Virginia Institute of Marine Science

The Virginia Wetlands Report

Summer 1991
Vol VI, No. 1

MEAN HIGH WATER MARK AND HOW TO LOCATE IT

Carvel Blair, Ph.D.
Associate Professor Emeritus, Old Dominion University
Chairman, VMRC Habitat Advisory Committee

To establish jurisdiction at a given site, a Wetlands Board must mark the locations of Mean High Water (MHW) and Mean Low Water (MLW) at that particular location. When dealing with a vegetated wetland, the Board must also mark the line whose elevation above MLW is 1.5 times the mean tide range (MTR). The phrases MHW, MLW, and MTR occur throughout the jargon of wetlands management. Everyone—board members, staffs, waterfront landowners, engineers, surveyors—has an idea of what these mean, but few can define them and fewer still truly understand the definitions. The purpose of this paper is to clarify the concept of MHW, MLW, and MTR; to explain how to lay them out on the ground, to distinguish between tidal and geodetic datums, and to suggest how these relate to permit enforcement.

Astronomical tide is the vertical movement of water caused by gravitational attraction of the sun and moon. Because the relative positions of sun, moon, and earth are continually changing over a 19-year period, the tides too change from one day to the next. Every 19 years the three bodies find themselves in the same geometrical relationship that existed 19 years before; every 19 years the astronomical tide is thus the same as it was 19 years earlier. MHW is defined as the mean (that is, average) vertical elevation of all the thousands of high tides that have occurred during the "metonic cycle" of 19 years. The definition of MLW is similar. MTR is simply the vertical elevation of MHW above MLW. Unless there is a change in sea level, therefore, the values of MHW and MLW are the same from one metonic cycle to the next. It is to these values that the wetlands statutes refer.

Determining MHW and MLW by literal application of the definitions is a long drawn-out, expensive procedure. In fact, MHW and MLW have been determined in this way at relatively few locations on the earth. Obviously a simpler procedure is necessary in practical engineering and regulatory situations. Several such methods exist for approximating the true values of these tidal parameters in a much shorter time at a much lower cost. Wetlands boards need to know (1) that such methods exist, (2) what kinds of people are qualified to use them, and (3) which method to apply in any given situation.

Fortunately experienced field observers can determine, by observation of a typical wetland or beach, a reasonably accurate approximation of the limits of Wetlands Board jurisdiction. Useful clues include barnacle growth on pilings, the wrack line on a beach, and vegetation patterns such as the saltbush limit.

(To teach this art, even if I could, is not my intention. In fact it deserves a paper of its own, written by biologists and geologists, supplemented by extensive field work.) The best policy in most wetlands cases is to set up a joint inspection including landowner, contractor, wetlands board staff or member, and VIMS scientist. Experience has shown that these parties usually agree on jurisdictional limits. When this agreement has been reached, the wetlands representative should mark the pertinent lines on the ground by inserting surveyor's flags at appropriate intervals. A dated color photograph, or a series of photos, should then be taken to document the agreement.

When the situation involves a request for a new structure, the next task is more difficult; designing the structure to the mutual satisfaction of the landowner and the board representative. Agreement is usually harder to reach, since motivations, experience, and viewpoints differ widely. Once the location of the structure is settled however, the process becomes straight forward. The issue is no longer "Where is the MHW line?" The issue is now the exact location at which the structure is authorized to be built. The wetlands representative should insert flags at the locations of key points (ends of bulkhead, turning points, toe of revetment, etc.) preferably using a different color from the MHW flags, and photograph them as a matter of record. The pictures will later prove useful, but they are not in themselves sufficient. It is also essential to tie in the flags, and thus the permitted location of the structure, to bench marks on the ground. The Board can then verify the location of the completed structure by simple survey techniques without arguing over MHW, MLW, and MTR.

In simple cases distances from each flag to a tree, a house corner, or a driven stake can be measured with a tape and recorded on a simple sketch. (Two such distances are needed to locate each flag; Figure 1.) More complicated structures demand the equipment and skills of a licensed land surveyor, who should prepare a detailed engineering drawing of site and structure. In either case it is the accurate, precise location on the ground of the permitted structure that will be pertinent during any subsequent enforcement action.

Sometimes a simple field determination of jurisdiction is not enough. A landowner charged with a violation, for example, may challenge the Board's determination of MLW, MHW, or MLW + (1.5xMTR). Courts have held that vegetation patterns alone are not legally adequate to define these parameters, so a more sophisticated technique becomes necessary. The hydrographic procedure termed "transfer of datum" generally produces legally defensible values of MHW, MLW, and MTR.

Unfortunately it is expensive and requires days, not hours, to carry out.

Transfer of datum requires two simultaneous recordings of tide height versus time. Data must be recorded over a period of days - ideally thirty or more. One recording is made at a standard tide station. In the lower Bay there are standard stations at Norfolk and at Gloucester Point. Here the 19-year tidal parameters are known, and tide height is measured continuously, year in and year out. The second recording is made at the wetland. A portable tide gage is mounted for thirty days, after which it is recovered and its data "dumped" into a computer. Data from the standard station for the same 30 days are entered, and the computer then prints out the values of MHW, MLW, and MTR at the wetland. The accuracy of these parameters varies but is generally within a few inches of the true values. The cost of such a procedure is usually several thousand dollars including the services of engineers or technicians.

Sometimes the technical literature contains values of MHW, MLW, and MTR determined by transfer of datum at a location a few miles from the wetland in question. The assumption can be made that these parameters also apply to the wetland, and their

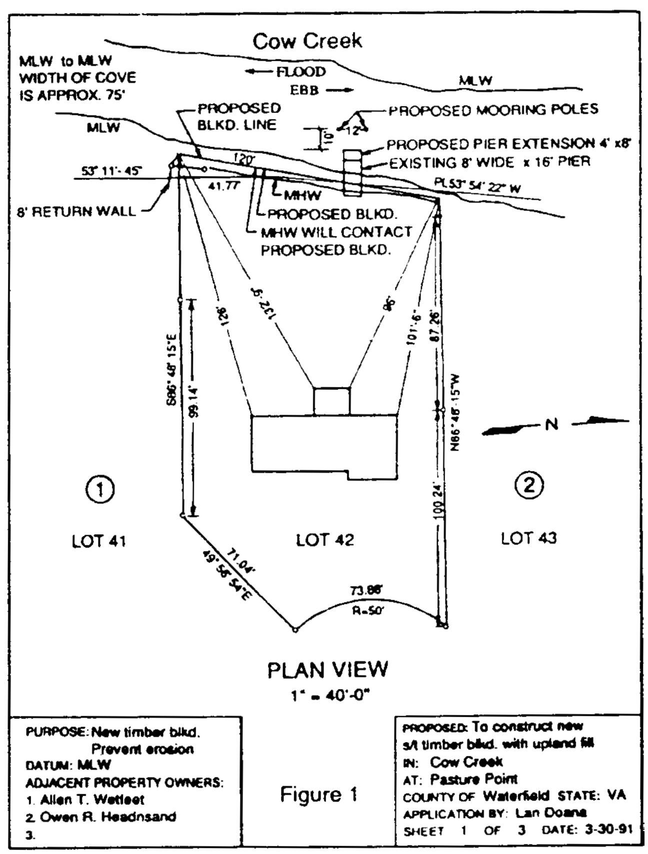


Figure 1

elevations laid out by simple land survey techniques. Such a process is quick and cheap, but it introduces an additional and unknown error. Which method to use becomes a value judgment influenced by such non-technical considerations as budgets, time available, and importance of the case.

Up until now we have been thinking of MHW and MLW as horizontal lines that can be marked on the ground. We have also discussed MTR—that is, the vertical separation between MLW and MHW. This separation is easy to measure at a small site like a half-acre saltmarsh. A surveyor could place one vertical graduated rod with its base on the MHW line and a second with its base on the MLW line. Using a level, he would sight on the MHW rod and read the height of his level line above the base of the rod. Then he would sight on the MLW rod and read the height of the level line above the base of the MLW rod. In a typical case the first reading might be 36.0 inches and the second 60.0 inches. The difference in vertical elevations gives MTR: 60. 0 - 36. 0 = 24. 0 inches.

Suppose, however, that we want to know the difference in elevation between MLW at Norfolk and MLW at Hopewell, distant 60 miles up the James River. Clearly no surveyor can set up his level to observe one rod at Norfolk and a second rod at Hopewell. There must be some other method to answer this question.

Until quite recently, scientists and surveyors believed that the answer lay in the concept of Mean Sea Level (MSL).

Intuition suggests that MSL the elevation of the sea surface, averaged over time must be the same everywhere on earth. If it were not, the waters of the ocean would "flow downhill" until they did attain the same elevation. In Tidewater Virginia, for example, this reasoning implies that the surface of the James River is horizontal at Half Tide Level—that is, half way between HW and LW. If this were so, we could use Half Tide Level as a reference. We could subtract one half of Norfolk's MTR from Half Tide Level, then subtract one half of Hopewell's MTR from Mean Tide Level. By comparing the results we could find the difference in elevation, if any. between MLW at Hopewell and MLW at Norfolk.

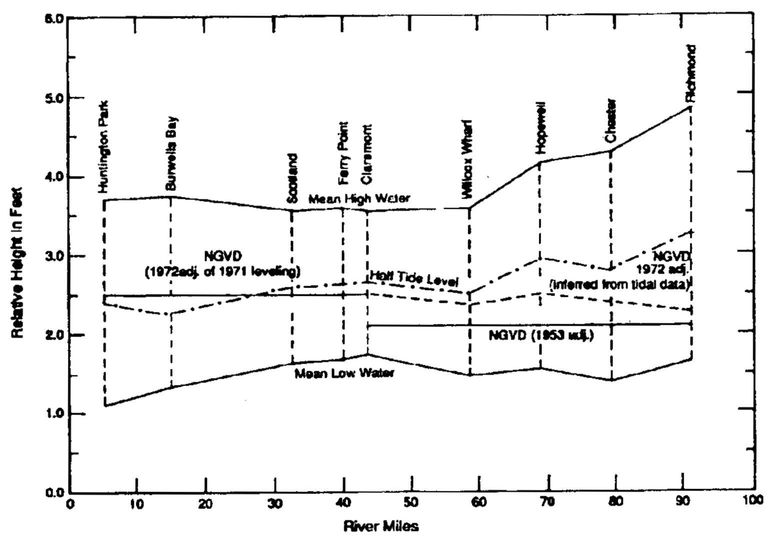


Figure 2. JAMES RIVER / DATUM DIAGRAM
(From Miles, 1980)

Our intuition would mislead us, however, for two reasons. In the first place, half tide occurs at different times at Norfolk and at Hopewell. In the second place, the elevation of half tide changes between Hopewell and Norfolk (Figure 2). Our search for a way to compare elevations must therefore continue.

Geodesists—scientists who measure the earth—have now discarded the concept of sea level as a vertical reference for elevation. The new reference elevation is termed "NGVD" -National Geodetic Vertical Datum. One can usefully think of NGVD as a point arbitrarily chosen on the earth's surface and marked by a durable benchmark. Although located near the seacoast, it was selected without regard to the height of the ocean waters. Having picked the location of NGVD, the scientists accurately determined its distance from the center of the earth. Then they established a continent-wide network of subordinate vertical datums, each with its own benchmark. Using sophisticated methods, they determined the distance of each subordinate datum from the center of the earth. It was then possible to compute the elevation of each such datum above NGVD. The locations and elevations of all benchmarks have been published and made available to surveyors and engineers.

Now we know how to find the relative elevation of MLW at Norfolk and at Hopewell. To begin, we take the necessary tidal observations to locate MLW on the ground at each site. Next it is necessary to locate a benchmark in the NGVD network near Norfolk and another near Hopewell. Using conventional land survey techniques, we then "level in" MLW Norfolk with respect to the NGVD benchmark at Norfolk, and MLW Hopewell with respect to the NGVD benchmark at Hopewell. Referring to the table of NGVD benchmark elevations, we calculate the elevation of both MLW's with respect to NGVD. With this information it is simple to calculate their elevation with respect to each other and answer our original question.

The term "datum" is used in another sense in cartography. Charts of coastal waters are usually based on a "chart datum" of MLW. Sounding figures and water depths are then understood to be presented as below MLW. Elevations of land features are above MLW. Land maps, by contrast, are normally based on NGVD; the printed height of a mountain peak is then its elevation above NGVD rather than above a tidal datum. Some maps show both land and water; in this case the user must examine the map legend to determine the applicable datum.

In summary, those who manage resources in the coastal zone should understand the distinction between tidal and geodetic datums. They can choose among several methods of locating MLW and other tidal parameters on the ground. The quickest and cheapest, although somewhat inaccurate, has proven adequate in handling the vast majority of wetlands management situations. More expensive and time consuming methods are available when the circumstances require greater accuracy. Whichever method is used, it is of uttermost importance that the permitted location of structures be accurately marked and recorded to permit subsequent follow-up and enforcement.

Editors Note: In addition to being Associate Professor Emeritus at ODU, Dr. Blair served 30 years in the U.S. Navy, retiring with the rank of Captain. He also served as chairman of the Norfolk Wetlands Board from its inception in 1981 until 1989. Dr. Blair's article not only derives from his intellectual abilities but also from his years of hands-on experience as a wetland board member in Virginia. ✚

BACK BAY WETLANDS INVENTORY

By Walter I Priest, III and Sharon Dewing

Back Bay has long been a significant aquatic resource in southeastern Virginia. Its vast expanses of emergent wetlands, beds of submerged aquatic vegetation and open water have provided excellent habitat for finfish, shellfish, waterfowl and furbearers. Despite their contribution to the resource value of Back Bay, little information has been available on the nature and extent of the wetlands component of this system.

Back Bay is a barrier spit lagoon isolated from the Atlantic Ocean by Sandbridge and False Cape. Geologically, the bay and its watershed are part of an old sand-ridge and mud-flat complex that consists of a number of roughly parallel sand ridges with intervening areas that were low lying mud flats. Portions of one of these ridges, Knotts Island Ridge, appear as the upland portions of Little Cedar, Cedar, Ragged and Long islands (Oaks and Coch, 1973). Much of the emergent wetlands surveyed in this inventory have apparently developed on the lower elevation lagoonal deposits in between these old beach ridges.

The closest direct link of Back Bay to the Atlantic Ocean is now Oregon Inlet, NC, approximately 60 miles to the south. Historically though, there have been several inlets along the barrier spit that provided more direct access to the ocean and lunar tides. Remnants of the flood tide deltas formed by these old inlets are evident in a number of locations along the barrier spit; particularly the Big Bull Island, Horse Island, Deal Creek complex along the North Carolina line. This was the location of the Old Currituck Inlet, which opened around 1650 and closed around 1729 (Hennigar, 1977). Back Bay also received periodic influxes of seawater during washovers prior to the stablization and enhancement of the sand dunes along the barrier spit during the 1930s. Since then overwashes have become more infrequent. The last major overwash occurred in 1962 during the Ash Wednesday storm.

The existing situation, with the closest oceanic inlet being very remote, virtually eliminates any influence of astronomical tides on water levels in Back Bay. Water level fluctuations are primarily attributable to wind tides. High water levels with a low average tide range usually occur during summer months with the predominantly south and southwest winds. During winter, water levels are generally low with a high average range because of the dominant northerly winds. The average water level at the Back Bay National Wildlife Refuge is 1.0 foot above mean sea level (MSL) with a maximum range in tides from -2.0 feet to 3.0 feet MSL during the period 1977 to 1983 (Roy Mann Assoc., 1984).

The field work for the Back Bay marsh inventory was performed during the months of August, September and October, 1977. Wetland locations and wetland boundaries were obtained by consulting USGS topographic maps and aerial photographs. The configuration and areal extent of each marsh was confirmed by observations by boat, on foot or by low level overflights. Individual plant species percentages are quantitative estimates of coverage based on visual inspections of every marsh.

This inventory identified 9925 acres of emergent tidal wetlands as defined by the State of Virginia. These wetlands supported over 109 species of wetlands plants. The five dominant species accounted for almost 75% of the wetland acreage. They included: cattails, *Typha* spp., (4004 acres), needlerush, *Juncus roemerianus*, (2371 acres), big cordgrass, *Spartina cynosuroides*, (605 acres), saltmeadow hay, *Spartina patens*, (449 acres) and switchgrass *Panicum virgatum*, (427 acres). The remainder of the species represented a diverse mixture of brackish plants with a significant component of freshwater species (Priest and Dewing, 1989).

Populations of *Lilaeopsis carolinensis*, a plant species ranked as extremely rare in the state and recommended for threatened status, were observed in several Back Bay marshes (Virginia Natural Heritage Program, 1990).

Defining the upper limit of wetlands in transitional areas between scrub/shrub and swamp communities was often problematical because it was difficult to discern the limits of periodic inundation required by the Virginia Wetlands Act. In questionable areas only that portion of the wetland which clearly met both the vegetation and inundation criteria was included in the inventory.

The USGS topograghic maps used as the base maps for this inventory were prepared in the early 1950s and photo revised in 1970 and 1971. As a consequence, there are a number of physiograghic and cultural changes that have occurred, e. g. considerable shoreline erosion has occurred in many places reducing the existing areas of wetlands including several small marsh islands that have completely eroded away. Additionally, several areas have been filled by dredge and fill operations, further reducing existing wetland acreage.

The dominant species in the emergent wetlands of Back Bay, cattail, *Typha angustifolia*, needlerush, *Juncus roemerianus*, and big cordgrass, *Spartina cynosuroides* are typically found in brackish marshes (Beal, 1977). These species are probably relicts from when Back Bay was directly influenced by the salinity and tides afforded by inlets to the ocean. The clear dominance of plants typically adapted to brackish conditions appears to indicate they are more suited to the varying salinity regimes of Back Bay than those more typical strictly freshwater systems. An example of this is the disappearance of the strictly freshwater American lotus, *Nelumbo lutea*, from the Asheville Bridge Creek-Muddy Creek complex when salinity levels became too high.

Another major change in the vegetation of the wetlands of Back Bay is a continuing one involving the dramatic spread of the common reed, *Phragmites australis*. During the period of the inventory the estimated percent cover of this species was 0.9 percent. Observations made during low level overflights in 1990 would indicate a rough estimate of average percent cover at up to 10 percent. The reasons for this spread are not clear. One plausible explanation would be that the large scale dredging and filling projects that occurred during the 1960s and early 1970s provided a sufficient disturbance of the natural flora that common reed had the opportunity to become firmly established. It has since been able to continue spreading by virtue of its aggressive growth habits that allow it to outcompete the native flora.

Literature Cited

Beal, E. O. 1977. A Manual of Marsh and Aquatic Vascular Plants of North Carolina with Habitat Data. North Carolina Agricultural Experimental Station Tech. Bulletin No. 247, North Carolina State University, Raleigh, NC.

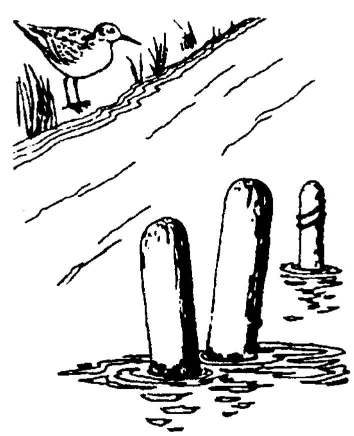
Hennigar, H.F. 1977. A brief history of Currituck Spit, Section 3, p. 1-21. In: V. Goldsmith (ed.) Coastal Processes and Resulting Forms of Sediment Accumulation Currituck Spit, Virginia-North Carolina. SRAMSOE No. 143, Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Va.

Oaks, R.Q. and N.K. Coch. 1973. Post-Miocene Stratigraphy and Morphology, Southeastern Virginia. Bulletin 82, Virginia Division of Mineral Resources, Charlottesville, Va. 135 pp.

Priest, W.I. and S. Dewing. 1989. City of Virginia Beach Marsh Inventory. Vol. 3. Back Bay and Tributaries. SRAMSOE No. 300, Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Va. 121 pp.

Roy Mann Associates, Inc. 1984. A Management Plan for the Back Bay Watershed, Vol. 2, Water Quality. Contract report prepared for the City of Virginia Beach, Va.

Virginia Natural Heritage Program. 1990. Rare Plants of Virginia. Department of Conservation and Recreation, Richmond, Va.✦



THE LIVING MARSH

Featuring plants and animals inhabiting or visiting the marsh ecosystem

Black Duck

(Anas rubripes)

Walter I. Priest, III

The black duck is a large mallard size duck which has a uniformly dark sooty brown body with a lighter, grayish head. The underwings are white and are a distinctive field mark when the birds are flying. Both sexes of black duck are very similar. They can be distinguished, however, by bill and feet coloration.

The distribution of black ducks is generally confined to the Atlantic and Mississippi Flyways of eastern North America. Nesting is concentrated in eastern Canada and the northeastern United States, particularly along the Atlantic Coast. The most important nesting area in Virginia is the Eastern Shore. Limited nesting also occurs along the western shore of Chesapeake Bay and in some inland areas. Wintering occurs from southern Canada and New England south to Florida and Louisiana. The majority of the Atlantic Flyway population winters between Long Island and North Carolina.

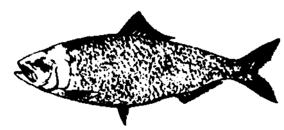
Spring migration begins in February and can continue into May for northern Labrador. Nesting begins from mid-March through April depending on the latitude of the site and can continue into June and July with renesting efforts if the first nest is lost for some reason. The majority of nests are usually located in upland areas adjacent to wetlands in cover ranging herbaceous growth like grasses, nettles and poison ivy tangles to forested areas to old duck blinds, but marshes are also frequently used. The average clutch size is just over nine eggs. Incubation lasts from 23 to 33 days depending on the temperature. It takes approximately 60 days for the new brood to reach flight stage. Adult black ducks molt after the breeding season and are flightless for several weeks, usually during the middle of the summer. Fall migration can last from late September until early December depending on the weather.

The food habits of black ducks reflect the many and varied habitats they utilize. In inland and tidal freshwater areas vegetation usually dominates including seeds from wild rice, pickerelweed, bulrushes, smartweeds, spikerushes, burreed and pondweeds where available. In coastal areas the amount of animal food can increase to as much as 95%. Important species include: periwinkles, mud snails, saltmarsh snails, blue mussels, ribbed mussels, baltic macomas, soft-shelled clams, various crustaceans including amphipods, decapods and crabs and even fish in some circumstances. Important plant foods in coastal areas include smooth cordgrass, eelgrass and widgeon grass.

As with most species of waterfowl black ducks have experienced a decline in numbers from the 1950s to the 1980s. According to information supplied by Fairfax Settle of the VDGIF, the long-term average decline has been approximately 3% per year. Population numbers have been relatively stable since 1985 when a number of harvest restrictions were implemented. Based on winter surveys, the Atlantic Flyway population of black ducks has averaged 224,000 between 1981 and 1990. The January 1991 flyway count was 233,000 as compared to 228,000 in 1990. In Virginia the long-term, 1981-1990, average has been 28,000. The Virginia mid-winter counts in 1990 and 1991 were both approximately 25,000.

A number of factors have contributed to the decline of the black duck including overharvesting, loss of breeding and wintering habitat along with competition and hybridization with released mallards. But hopefully this trend will be reversed as new conservation measures are employed to protect the black duck and its habitat.

Atlantic Menhaden



(Brevoortia tyrannus)

Lyle M. Varnell

Atlantic menhaden is one of the most important fish species in North America. It is a valuable, high calorie prey species of great abundance. It is also important to the commercial fisheries as a source of oil and fish meal, and as bait for crab pot fishermen and recreational chummers.

Atlantic menhaden belongs to the Family Clupeidae, which also includes American shad, alewives and other herrings, and sardines. Like their close relatives, their bodies are strongly compressed with a deeply forked caudal fin, and they have a single dorsal fin located at midbody. Atlantic menhaden is distinguished from other clupeids by its silvery body with a dark bluish-green back. Its sides have a brassy hue and numerous spots posterior of a dark shoulder spot. Atlantic menhaden may reach 10 years of age and sizes of 14-15 inches in length. Three other species within the genus *Brevoortia* occur in United States waters. Yellowfin menhaden (*B. smithi*) are infrequent stragglers to the Chesapeake Bay area; occurring mainly below North Carolina. The Gulf menhaden (*B. patronus*) and the finescale menhaden (*B. gunteri*) occur almost exclusively in the Gulf of Mexico.

Atlantic menhaden are found in ocean and coastal waters from Nova Scotia to Florida. During summer months, older fish are concentrated in waters off of the New England states and Eastern Canada, while younger, smaller fish are found in the Chesapeake Bay area and the South Atlantic. Beginning in the fall, southern migrations along the coast occur to overwintering grounds below Cape Hatteras. Northern migrations, usually along the 50° F isotherm, occur the following spring.

Spawning occurs offshore in almost all months in some part of its range. Spawning in the waters off of Chesapeake Bay occurs primarily in the spring and fall. Although spawning occurs mainly offshore, spawning activity also occurs infrequently in estuaries. After hatching, larvae migrate towards shore. Larvae (about 1/2 inch long) are found in the Chesapeake Bay tributaries during May, June, and November mainly in waters less than 3 ppt salinity.

Young-of-year Atlantic menhaden (less than 2 inches long) are generally restricted to estuaries, and are inhabitants of the Chesapeake Bay from May to November. Overwintering of the juveniles within the bay occurs, but most migrate to coastal waters at the end of their first summer. Adult menhaden are in greatest abundance in offshore waters adjacent to major estuaries, but large schools frequently enter estuaries.

Atlantic menhaden, especially sub-adults, are frequent visitors to tidal marshes in the Chesapeake Bay area. Tidal marshes provide refuge from predators, and are an important food source for all life history stages. Menhaden are primary consumers- that is, they are herbivores, or plant eaters. Their diets consist primarily of phytoplankton and detritus. At times, detritus may be the sole, or primary, dietary component. Atlantic menhaden have been reported to consume salt marsh plant detritus at high efficiencies. Therefore, tidal marshes play an important role in the life history of this important fishery species.

Technical Reports - Flora Series Presently Available

90-2 *Spartina alterniflora* (Saltmarsh Cordgrass)

90-4 *Spartina patens* (Saltmeadow Hay)

90-6 *Peltandra virginica* (Arrow Arum, Duck Corn)

91-1 *Phragmites australis* (Reed Grass)

91-3 *Sagittaria latifolia* (Arrowhead, Duck Potato)

91-5 *Pontederia cordata* (Pickerelweed, Tuckahoe)

91-7 *Acer rubrum* (Red Maple)

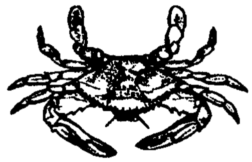
ANNOUNCEMENTS

With the aid of a Coastal Resources Management Grant, the Wetlands Advisory Program at VIMS is preparing a Wetlands Management Handbook which will be available in the October-November time frame. The handbook will be distributed free to the board members and support staff of all localities having local wetlands boards.

The Wetlands Management Handbook is designed to contain all information and technical support necessary for wetlands staff and board members. It is intended to be updated as new information becomes available. When a board member steps down from his post, his handbook will go to his successor. This will allow new members to have up-to-date technical support as soon as they are appointed.

The Handbook will contain copies of all pertinent laws, guidelines and advisory documents. In addition, it will house legal guidance, suggested additional readings, botanical information and additional guidance on shoreline erosion control structures. Contact Tom Barnard at VIMS if further information is desired.

WETLANDS RECIPES



Sauteed Soft-shell Crabs

Wash and remove excess water. Season with salt and pepper (other spices to taste) and dip in flour. Heat 6 tablespoons of butter and 2 tablespoons of oil in skillet. Cook about 4 minutes per side until delicately browned and crisp.

(From **The Soft-shell Crab**, VIMS Sea Grant Advisory Service)

Buttered Asparagus

4 dozen asparagus spears
1 tbsp. salt
2 cups boiling water
1/4 lb. butter

Place asparagus in salted, boiling water, lower heat, and simmer until tender. Remove from water and pour melted butter over asparagus.

(Steward and Kronoff, 1975, **Eating From the Wild**)

This Issue's Quote

"His proposal is dangerous because it plays to wishful thinking that there is no need for fundamental change in the design of our civilization and that, with a little creative engineering, we can outsmart nature once again. The truth, however, is that we cannot, without serious repercussions, continue our hubristic campaign of re-creating the environment.." **Senator Al Gore, 1991, in a letter to the editor of Discover magazine regarding John Martin's proposal to use iron fertilization of the the Southern Ocean as a partial solution to global warming.**

Wetlands Program

The Virginia Wetlands Report

is a quarterly publication of the Wetlands Program at the Virginia Institute of Marine Science of the College of William and Mary. Subscriptions are available without charge upon written request to : Wetlands Program, Virginia Institute of Marine Science, P.O. Box 1346, Gloucester Point, VA 23062

Editors: Kirk J. Havens and Thomas A. Barnard, Jr.
Dr. Carl Hershner, Program Director
Nameplate designed by Dianne Bowers
Typography by Ruth Hershner

VOL. VI, No. 1 SUMMER 1991

In this issue. . . .

Mean High Water Mark and How to Locate It 1
Back Bay Wetlands Inventory 4
The Living Marsh 6
Announcements 7
Wetlands Recipes 8

This publication is printed on recycled paper.