Letter From the Desk of David Challinor
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The largest estuary in the United States is the Chesapeake Bay. It runs for roughly 175 miles from just above the mouth of the Susquehanna River south to the Bay's mouth, between Cape Henry and Cape Charles at the end of the Delmarva Peninsula. An estuary is a semi-enclosed body of water where fresh water from the land mixes with salt water from the ocean. The Chesapeake Bay receives run-off from several rivers, including the Patuxent, Potomac, Rappahannock, York and James. Nearly half of the fresh water entering the Bay comes from the Susquehanna that flows into the Bay's north end. This month's letter is about the Chesapeake Bay and the Smithsonian's research effort to understand this extraordinarily complex but nutrient-rich body of water.

The Smithsonian's direct involvement in Bay research began in 1964 when it was unexpectedly bequeathed a 400-acre abandoned dairy farm. Its owner had shut down his operation in 1946 after losing his contract to supply milk to the nearby Naval Academy. When notified of this windfall, several Smithsonian regents wanted to sell the farm and add the proceeds to the Smithsonian's endowment. Secretary Dillon Ripley, however, visited the site and, despite poison ivy smothering the farm buildings and second growth forests reclaiming the pastures, recognized its value as a research facility. The 14 miles of shoreline eventually acquired by the Smithsonian through gift and purchase were ideal for estuarine research, and the forest and farmland were perfect for watershed modeling. Its convenient location is halfway between Washington and Baltimore on the Rhode River just south of Annapolis. The facility, known as SERC (Smithsonian Environmental Research Center), has about 2,700 acres with 20 scientists and 100 support staff.

The Center has monitored nutrient cycling in its forests, salt marshes and fields leased to local farmers to grow corn and soy beans. Monitoring run-off is important in managing the Chesapeake because the principal rivers that drain the Bay's watershed flow through some of the richest farmland in the country. Much of the nitrogen and phosphorous applied to the principal crops on the watershed end up as dissolved nutrients in the Chesapeake and become a continual threat, especially in the shallow coves, of eutrophication (a condition created by excessive nutrients and full sunlight allowing aquatic plants and phytoplankton to grow so quickly and thick that they cover the water surface). Rooted aquatic plants are thus deprived of light for photosynthesis, and the death and decay of the phytoplankton blanketing the surface water plants uses up all the oxygen to fuel the bacteria that decompose the dead plants. The decay proceeds to the detriment of the fish that also need oxygen in the water to breathe.

In one large-scale experiment at SERC, the contract farmer regularly reported exactly how much and when he applied fertilizer on a corn field that sloped towards a small stream. The stream was a tributary of the Rhode River, which in turn flowed into the Chesapeake. An analysis of the chemicals dissolved in the stream showed that about 85% of the nitrogen and phosphorous applied to the soil was used by the crop. If the crop was planted all the way to the stream bank, however, the unused balance of 15% went into the stream. Scientists then measured how much of this unassimilated 15% would enter the ground water and the stream if a 10 m (33 ft) wide barrier of trees and bushes provided a buffer between the crop field and the stream bank. The uncultivated, natural barrier intercepted about 80% of the 15% excess not used by the crop; thus only about 3% of the unused nutrients entered the Bay. These percentages are of necessity approximate and vary according to the crop being fertilized, its stage of growth, recent rainfall patterns, etc. The vegetated strips parallel to the streams assimilate surplus nutrients and their soil microbes further assist in dinitrification which make these strips important for pollution control.

Although such a strip is a relatively simple palliative to a major eutrophication problem, a complicated policy question arises. The farmer believes that it is more profitable for him to cultivate his entire field and therefore feels he should be compensated for the 10m-wide swath left fallow. Lowering the nutrient runoff from a watershed reduces surface algal growth and improves fish habitats. Should sport fishermen subsidize farmers to gain a cleaner, more fish-productive Bay? If so, how would the funds be collected and allocated? Should water skiers, sailers and others whose Bay experience would be enhanced by cleaner water also be taxed? Although often discussed in the legislature, no resolution is imminent. However, some action is being taken as reported in the attached article from *The New York Times*.

Certainly man-induced additives to the Bay affect its health. Assaults arise from leaking septic tanks, heavy metal contaminants from soil dredged to deepen Baltimore harbor, inadvertent oil spills, and storm sewer overflows after heavy rainstorms. Only the open south end of the Bay enjoys the benefit of tidal flushing of contaminants; the brackish water of the northern Bay moves slowly south and takes considerable time to cleanse itself.

About 25 years ago Hurricane Agnes struck the east coast in September. Ten inches of rain fell on the Bay's northern watershed and fresh water from draining rivers diluted the normal low salt content of Bay water around SERC. At less than one salt part per thousand parts of water the Bay was essentially fresh, not brackish, and the consequences were dramatic. The cold winter that followed the floods of Agnes provided some of the best ice skating I have ever enjoyed through the marshes and bays surrounding the Center. Although a commercially valuable clam crop disappeared because of the decline in salinity, the loss was offset by the elimination of the local stinging jellyfish. The change in salinity caused them to drop to the bottom as small cysts where they awaited the inevitable flow north of salty ocean water and the re-creation of the conditions necessary to crank up their life cycle once again. For about three summers swimmers and water skiers reveled in a jellyfish-free upper Chesapeake.

The profound changes triggered by wind and rain are beyond human control and any attempts to stem the tide are often as futile as those of King Canute. In 1966 Poplar Island was donated to the Smithsonian. The island was part of a complex of three or four islands near the Bay's eastern shore, about a 45-minute boat ride from SERC. Two hundred years ago Poplar was part of one large island of 2000 acres farmed by several families. Poplar Island with its house and adjacent pier had been used as a hunting lodge for many years. For about a decade the island was used to study the population dynamics of small rodents, but it soon became apparent that the island was vulnerable to erosion from waves generated from northerly storms. The island's north shore was eroding at 5' or 6' a year, so to protect its facility the Smithsonian spent $200,000 building a bulkhead along the eroding shore line and backfilling it with oyster shells. At best it was a temporary palliative; two years later a winter storm breached the barricade and the inevitable distintegration of this once large single island inexorably continues. The Institution sold the island about 15 years ago when it could no longer justify attempts to stem the tide.

Currents disperse the soil from Poplar Island and other exposed shore lines around the Bay bottom and contribute to the shifting shoals for which the Chesapeake is well known. Ample evidence exists of the siltation rate within the Bay and its tributaries. For example, a SERC neighbor showed me an oil painting from about 1840 depicting a cargo sailing craft anchored in an easily recognized spot near Corn Island in the Rhode River. The loaded vessel probably drew about 4-1/2 feet. Today there is barely three feet at that spot. Bereft of strong tidal action to flush the increasing sediment load being washed into the upper Bay, scientists can only speculate how long it will take for the Chesapeake to become a large marsh with a dredged channel from its southern entrance to Baltimore. It may be 5,000 years away, an instant in geological time, but too far in the future for the human time frame.

Politically, the Chesapeake is a highly visible estuary. Although it cannot be seen from the top of the Capitol's dome, it becomes visible within minutes after takeoff from Washington's National Airport. Its prominence has spawned scores of long-term studies, separately and in concert, by universities and government agencies. The Chesapeake Research Consortium (Smithsonian, Johns Hopkins, University of Maryland, Virginia Institute of Marine Sciences, Old Dominion University, and the Philadelphia Academy of Natural Sciences) was organized in 1971 and is still going strong. These universities, the National Science Foundation, and the Environmental Protection Agency's Chesapeake Bay program all contribute to the research funding. The latter has recently underwritten a six-year, $3 million project called Trophic Interactions in Estuarine Systems (TIES), whose goal is to understand the physics of the Bay: how its fresh and salt water mix, for example, maintaining the high productivity of this ecosystem. Another example of Congressional beneficence was the Corps of Engineers' 14-acre scale model of the Bay, complete with pumps to replicate its water movement. When I visited this marvel on Kent Island at the east end of the Bay Bridge about 15 years ago, it was the world's largest covered space under one roof. I did not believe the results obtained would be accurate because at that scale an uncontrolled alteration of a fraction of an inch in the model's topography would drastically distort calculated water flows to the degree that they would no longer be applicable to the reality of Bay bottom contours; thus any resulting data on the actual physics of water circulation patterns would be rendered useless. The model has been abandoned because today's sophisticated computer technology is more accurate and considerably less expensive in studying large-scale water movement patterns.

This short account of Chesapeake Bay research shows that a politically powerful constituency can get studies funded. Although the research results are applicable primarily to the Chesapeake, much of what has been learned can be applied to other estuarine systems. The Chesapeake, although still productive, is but a shadow of its former bountifulness. Oystering is no longer a commercially viable industry; today's harvest is only one percent of that of 1900. The Bay's famous blue crab harvest this year (1998) is the lowest ever recorded. Striped bass and its close relative, white perch, are two popular sport fish that have made a modest comeback. But other species, such as yellow perch, have not spawned in SERC's Muddy Creek since 1970. Acid rain run-off into the Creek's spawning grounds evidently caused their demise. Much research must still be done to reverse the declining productivity, and fortunately public awareness of the problem and its solutions is growing. *The New York Times*' clipping gives hope that help may be on its way.

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