Voyages into the Future

In the steamy year 2100, we'll not be the only sights long gone

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Text originally appeared in *Bay Weekly* Volume 15, Issue 34, 2007.

Chesapeake Winter

On these sizzling summer days, a live-aboard's fancy naturally turns to thoughts of … global warming. Our own Chesapeake region is heating up, not just in summer, and sea-level rise is accelerating around the Bay. What might it be like, living on our trawler Bright Pleiades almost a century from now, dropping anchor at favorite Chesapeake destinations in the steamy year of 2100?

Mathematician and thinker Allen Hammond has written that "scenarios are not predictions or forecasts. Rather they suggest how the world might turn out."

That's what we've done in imagining our ship's log from future journeys:

Bright Pleiades Ship's Log, January 15, 2100
Solomon's Island, Maryland

Our trawler is anchored behind Solomon's Island near a submerged shoal, once the small islet called Moll's Leg. Anchored boats surround us; it's been a balmy January and global warming has extended the Bay's cruising season.

Nearby, the low ground where the Tiki Bar, a Solomon's landmark, once stood, has been eaten away by the waves.

Court Stevenson, botanist at University of Maryland's Horn Point Laboratory, studies rising waters in Blackwater National Wildlife Refuge.

The core of the island behind has been built up several feet, and Chesapeake Biological Laboratory buildings have been raised.

We row ashore seeking oysters for dinner. Bunky's, the last oyster shucker on the island, closed decades ago. Descendants of Solomons' watermen now practice oyster aquaculture on a small but sustainable scale around the island, using oysters specially bred to mature quickly to harvest size before they succumb to disease.

Sea level has risen more than three feet over this century, consuming the sandy beach on the Patuxent River side of Solomons where windsurfers used to launch.

We hitch a ride to Calvert Marine Museum, which was forced by flooding some years back to move north to higher ground along Route 4. From the museum's featured exhibit on how global warming has changed local ecology, we learn that the Bay occupies a "transitional biogeographic region."

In earlier times, the Bay's soft clam was near the southern end of its range, so it no longer survives in warmer waters here. A new shrimp species has moved in from the south. Overall, climate change, for a number of reasons, has reduced the richness of the Bay's biodiversity.

This glimpse of a future Solomon's Island has some basis in the present. "Global warming is already upon us and some … additional warming is inevitable," reports the Union of Concerned Scientists. Last year — 2006 — was the warmest recorded for the lower 48 states.

"Eleven of the 12 warmest years on record have occurred in the past 12 years," reports the Intergovernmental Panel on Climate Change. By 2100, the panel predicts, worldwide temperatures will increase three to seven degrees Fahrenheit. Human activity, especially fossil fuel burning, is the major impetus for the warming, said the panel in February.

Other studies suggest the mid-Atlantic region, including Chesapeake Bay, may warm six to 12 degrees more in future summers. Bay waters also are heating up. The 20th century Bay was three to five degrees higher than the

mean of the past 1,000 years, according to Thomas Cronin of the U.S. Geological Survey and others.

Some Do Not Like It Hot

Animals and plants have already changed in response to 20th century warming. A study of 1,598 species showed that 41 percent have changed their range or when they reproduce or develop in response to warming, according to a review by ecologist Camille Parmesan last year.

In the Bay, animals that need the shoreline, like shorebirds, terrapin and horseshoe crabs, may lose out. As sea level rises due in part to global warming, and humans develop the shore, habitat at the sandy edge disappears.

For creatures and plants in Bay waters, a possible future scenario is that greater rainfall could decrease salinity in the north, while a rising sea level could boost salinity from the south, creating what Horn Point Laboratory biologist Victor Kennedy terms a "biological squeeze." This could limit habitat for animals sensitive to salinity.

Pinpointing the actual winners and losers of warming is a speculative exercise. Perhaps the only certainty is the one forecast by the Chesapeake Bay Program's Scientific and Technical Advisory Committee: "biological surprises lie ahead."

Searching for Higher Ground

The consequences of current sea-level rise are already before us. Old graveyards awash on Chesapeake shores, historic islands with shoals as their own tombstones, storm surges flooding such Bay towns as North Beach and Annapolis — all dramatize rising Bay waters. They're rising, in fact, twice as fast as the world average. The Bay is ranked the third most vulnerable area to sea-level rise in the U.S., behind Louisiana and Florida, according to the Maryland Department of Natural Resources.

To be sure, the Bay has been rising ever since the end of the last Ice Age.

"For the Chesapeake Bay, the rate of sea-level rise has certainly accelerated, but just as certainly, rising sea level is the norm in the region rather than the exception," notes geologist Curtis Larsen. About 6,000 to 7,000 years ago, he says, when the Chesapeake began to assume its current shoreline pattern (the shape of a "drowned river valley"), sea level was almost 30 feet lower than now.

The longtime rise in sea level, however, has accelerated in the 20th century. It is fastest at the Bay's mouth — 1.3 feet per century — and decreases up-Bay to about one foot of rise at Solomons. There, Larsen points out, the marshes of colonial times have become shallow creeks, and silvery trunks of dead trees rise from areas newly evolved into marsh.

Over the past 5,000 years, Bay waters rose about three feet per 1,000 years. In the 21st century, they could rise three feet in just 100 years: 10 times as fast, according to a report by several U.S. federal agencies.

Two factors drive the local rise. Global warming is one. Hotter oceans expand, while melting glaciers and ice sheets add to the oceans' volume. But Chesapeake Country is sinking, as well. To the north, during the Ice Age, the ice sheets depressed the Earth's crust, and the Chesapeake region — on the other end of the seesaw — rose to compensate. When the ice melted, the land beneath rebounded, and the Chesapeake, on the opposite end of the fulcrum, began to sink again in a long, slow process that will continue far into the future.

Maryland has about 7,525 miles of shoreline. Over two-thirds of the coastline is now eroding, and about 48 miles of shoreline lose more than eight horizontal feet per year, according to Maryland Department of Natural Resources estimates.

Islands Going, Going, Gone

Today, a tilting rust-red lighthouse is the only clue to the location of Sharp's Island, once 890 acres. Along with Sharp's, at least 13 Chesapeake islands have vanished since Europeans arrived. Islands are the most vulnerable shorelines.

Poplar Island lost almost all of its 1,400 acres mapped by Captain John Smith (although the island is now being rebuilt with dredged material from the channel to Baltimore). Barren Island lost 64 percent of its area and Hooper Island 21 percent, according to a DNR report in 2000. Most of what's left of Smith Island, reduced by 29 percent, stands

less than three feet above sea level. James Island, 976 acres in 1848, was 92 acres by 1994. Tilghman's 2,015 acres in 1848 dwindled to 1,302 acres by 1994.
Lost islands carry away unique human culture and precious wildlife habitat. The vanished outposts also no longer absorb the battering of storms and stand no more as a first line of defense for the coastline behind.

If heavily bulkheaded Solomon's Island survives until the year 2100, it will probably be because humans have decided it is worth the cost to fortify it further. Its perimeter is already significantly hardened. That may rob remaining marsh areas of the sediment needed to grow vertically to keep pace with sea-level rise, says Marcia Berman of the Virginia Institute of Marine Science. She and colleagues have surveyed over 4,000 miles of Maryland shoreline by small boat.

In a place with the economic and social value of Solomons, Berman says, "It is unlikely that humans will retreat. It is more likely that they will do as they have always done: rebuild and repair. In 100 years there will probably be enough landscape left to justify it; in 200 years, maybe not."

Bright Pleiades Ship's Log, June 7, 2100
Annapolis, Maryland

We've secured Bright Pleiades to a city mooring in Annapolis Harbor. A water taxi, skimming through water thick with sea nettles, has dropped us off at the towering sea wall built at enormous cost a quarter-century ago after Hurricane Leonardo devastated Annapolis; its storm surge made Isabel's four-to-eight-foot surge here seem tame.

We climb steps over the wall and down into the market area. Near a line of outdoor cafés crowded with people, a historic plaque commemorates Ego Alley, a waterway long since enclosed within the seawall, filled in with earth and planted with grass. From a café table we cannot even see the Severn River beyond, but historic Annapolis is protected.

The blistering heat drives us indoors for dinner. Global warming's higher humidity makes even these early June days feel hotter. We head for McGillavray's, famous for its "Maryland-style" crabcakes. Virtually all crabcakes at restaurants around the Bay are now made with crab imported from Asia. All-you-can-eat feasts of local crab are just a memory; we save the pricey Chesapeake blues to savor on special occasions.

Tall, distant buildings shimmer in the heat, home to the throngs who have come to live around Annapolis. Although the Severn's shores are completely bulkheaded, few new buildings are going up close to the water, since insurance companies long since stopped writing policies on buildings near the shore.

This imaginary future Annapolis reflects some present-day realities. For one, jellyfish like the Bay's familiar sea nettles seem to be increasing in estuaries around the world, and warming could be a factor.

As for nonindigenous crabcakes, many consumers have no idea that the entrée's prime ingredient often comes, already, from waters far from the Bay.

"Today, the vast majority of restaurants serving crabcakes in the Chesapeake Bay watershed use imported crab meat," says Michael Paolisso, a University of Maryland anthropologist who studies Chesapeake culture. "Most of the meat sold in supermarkets is imported crab, packaged in a way that the average consumer would assume that the meat is from the Chesapeake or Maryland or Virginia."

People Pouring In

A crowded future Annapolis reflects current projections. The watershed's population is almost 16.5 million now, with 300 more people moving in every day (see the population clock on the Chesapeake Bay Program's website, http://www.chesapeakebay.net/info/pop_result.cfm). Urbanization and development may rival climate change in their impact on streamflow in the Chesapeake watershed, some scientists say — and streamflow is critical to Bay water quality.

As people flood in to live along the Chesapeake's coastline, many understandably seek to protect their property against sea-level rise. Considerable miles of shoreline are now artificially fortified in some way or other. The inventory by Virginia Institute of Marine Science's Berman looked at over half of Maryland's shoreline; one-half of that surveyed area was armored.

While shoreline hardening may be a short-term fix for a property owner, overall development, including the paving-over of wetlands, makes coastal areas more vulnerable to storms. That's a point Hurricane Katrina drove home.

And rising sea level alone means that weaker storms can pack a bigger punch than in the past. The storm surge of Hurricane Isabel flooded areas left dry by a similar hurricane in 1933 because the sea level had risen about a foot higher in the interim. In the future, winter storms might also increase, and storms may also become more intense.

Hurricane History

Could the increased frequency of U.S. hurricanes in the past few years be the atmosphere returning to business as usual? A report published in June in the journal Nature reconstructed hurricane history over the past 270 years. Within that timeframe, say the authors, recent increases in hurricanes in the North Atlantic match other periods of frequent hurricanes. The seeming uptick in frequency "thus appears to represent a recovery to normal hurricane activity."

Global change makes the benchmark of a 100-year storm only a snapshot in time. FEMA maps the 100-year floodplain, an area with a one percent chance of being flooded in a particular year. Many such Maryland areas were mapped over 19 years ago, according to a Maryland Department of the Environment report. With higher water levels, the currently defined 100-year storm will hit an area every 25 or 30 years. Also, a 100-year floodplain may not have a uniform chance of flooding; lower sites and those nearer the water may flood more often. It's not a stretch to wonder whether homeowners, current or prospective, should be alerted to such trends.

New arrivals to the coast may turn a blind eye to the rising tide, but insurance companies may be seeing the light. In February 2007, Allstate stopped insuring new properties in many areas of coastal Maryland.

Eroding shorelines, flooding towns and massive loss of wetlands are all too familiar in today's Chesapeake watershed.

"In the mid-Atlantic I think we're just one major storm away from a panic about this," says Michael Kearney, a University of Maryland geographer. "We don't have 50 years. We have to worry about it now."

Bright Pleiades Ship's Log, November 10, 2100
Blackwater National Wildlife Refuge

Cruising north today along the Eastern Shore, we edged outside the one-foot contour interval on our chart that marked the former site of Smith Island, a watermen's community and magnet for tourists even into the 21st century. In the Bay, we passed over huge areas once covered with eelgrass meadows, the past mainstay of waterfowl and many other species such as fish and juvenile crabs. Now, new species of grasses, better adapted to heat, have moved in from farther south. It remains to be seen whether they will be as valuable to the ecosystem. En route, we counted numerous colonies of brown pelicans on the shoreline, southern immigrants that now nest up and down the Bay.

We've dropped anchor in the central Blackwater Refuge where, maps show, marshland thrived a century ago.
In the setting sun, the waterscape of Blackwater appears wild and beautiful, but we know it has long been altered at the hand of man. It has been channeled, dredged, dammed, burned and now, its small remaining marsh area must be carefully tended — artificially maintained with sediment dredged regularly from the approach channels to Baltimore. With moonlight reflecting on the open water, we can only conjure the endless marshland stretching to the horizons, sheltering a spectrum of waterfowl long gone.

Blackwater National Wildlife Refuge: No Parking Any Time.

Tomorrow, we'll attend the annual Waterfowl Festival in Easton, whose duck-callers, retriever contests and celebrated carvers commemorate a waterfowl hunting tradition preserved mainly in myth and museum.

Tidal marshland exists within a dynamic balance of land and water. Blackwater, the Chesapeake's largest marsh, has been losing ground fast: one-third of its marsh from 1938 to 1988. Oft-quoted predictions say the marsh, unable to keep up with sea-level rise, will disappear in 30 years or less. Shoreline erosion, sinking land from groundwater extraction and problems with sediments and nutrients have all degraded the marsh.

"By 2100, I'd say the marsh system will be gone," says Kearney, who has studied marsh loss. Even if marsh restoration got underway, "we have maybe 20 or 30 years if we start now."

"Blackwater is definitely the poster child of the Bay," says Patrick Megonigal, Smithsonian Environmental Research Center biologist who has studied how wetlands respond to climate change.

Rising Chesapeake waters erode a forest along Hughlett Point, Virginia.

Blackwater's habitat exemplifies why nearly one million ducks, geese and swans come to the Chesapeake to feed and rest in winter, and why other birds use it as a migration oasis. But the waterfowl species that come, and how they use the Bay, have already changed greatly in the past 50 years. One major reason is the loss of a key food resource: submerged aquatic vegetation.

Wintering canvasbacks, perhaps the signature Chesapeake duck, have switched their diet from wild celery and pondweed to Baltic clams. Other ducks — pintail, redhead and American widgeon — have mostly stopped coming at all. Higher temperatures and hypoxia (oxygen-starved dead zone) have degraded the ducks' food resources, while imported swans and Canada geese that now linger year-round further consume submerged vegetation.

Against All Odds

During a tour of present-day Blackwater, flooded roads threading through the marsh and submerged yards testify to rising waters.

"An inch means a lot around here," says Court Stevenson, Horn Point Laboratory botanist, guiding us to Shorter's Wharf, where studies show the marsh is 3,800 years old. En route, we see local workboats tied at a dock whose names seem to comment on the marsh's survival: one is called Ironic; the other, Against All Odds.

The marsh has lost significant ground within a human lifetime.

"A lot of ecology is like watching the paint dry, but this thing moves fast," Stevenson says.

The hurricane of 1933 put the Blackwater's headwaters — seven feet elevation — underwater, but no one seems to remember that now, he says. Attempts to build several thousand houses on the upland area were curtailed last year, although a smaller project is going forward.

Stevenson describes a proposal to dredge material from Baltimore's approach channels and spread it over the marsh, supplying sediment so plants can keep up with rising sea level. A review panel will evaluate the plan's feasibility; a small pilot project is slated to begin in 2008.

Curtis Larsen, who has also studied the marsh, believes that

it is actually moving upward and inland with rising sea level. “Coastal refuge planning needs to move beyond present marsh boundaries, but county planners and real estate interests over there don’t want to hear it,” he says.

‘Take the Current or Lose Our Ventures …’

The current anniversary of Captain John Smith’s explorations has inspired imaginative sketches of the Chesapeake Bay he encountered. But his Bay, like ours, is only one of many Chesapeakes through time, including the Bay of 2100 beyond the horizon. Through our actions, we humans are already choosing the shape of the future Bay.

“In general, it’s not a big mystery as to what is going to happen,” says Kearney. Scientific predictions of warming and sea-level rise track closely. “It becomes a political and social issue more than a science issue,” he says, “involving changes in lifestyle and also a cost.”

We of the Bay watershed cannot alone prevent climate change. But we can prepare for change and restrain the extent and consequences of global warming. If we can restore the Bay, those actions will also help check climate change.

Future climate is not set in stone. Looking at the predictions of nine climate models in the journal Climate Dynamics last year, authors Katharine Hayhoe and others found great agreement on “the fundamental role of future [human-caused] emissions in determining the potential magnitude of changes we can expect over the coming century.”

In other words, by reducing emissions now, we can choose a future climate that is less severe for the Bay and the world at large.

On such a full sea are we now afloat, and we must take the current when it serves, or lose our ventures, warned Brutus in Shakespeare’s Julius Caesar.

The waters of the Chesapeake mingle with the full sea of the world, and the currents of Chesapeake climate change interweave with those around the globe. Whether we will embark on Shakespeare’s current is a scenario we are writing.

Sidebar: Maybe, Maybe Not:
Prediction Is Slippery Business

Global warming is here, most scientists agree, and we humans have caused it. Over the last quarter-century, the level of carbon dioxide in the atmosphere has risen higher than it’s been for at least a million years.

Evidence for warming is pervasive: glaciers melted through the 20th century, the Greenland Ice Sheet is melting, Arctic sea ice has shrunk, the oceans are warmer and sea level is rising.

Working internationally through the Intergovernmental Panel on Climate Change, scientists use some 20 complex computer models to study how the atmosphere, oceans and land interact, and to predict future climate.

Down at the regional scale, however, the details of future climate can blur, so global predictions are more likely than local forecasts. Likewise, predictions over a broader time are more reliable than forecasts for a particular season like summer or fall.

Predictions for the mid-Atlantic can be ranked according to degrees of certainty, says Ray Najjar, who studies mid-Atlantic climate change at Pennsylvania State University. A population increase in the watershed is very likely. As for warming, every climate model predicts it, but some differ in degree.

Precipitation and streamflow may increase, and precipitation may fall more unpredictably, but these effects are less certain on a regional level. Models predict higher precipitation in winter and spring in the Chesapeake region with some consistency, but they are less certain for summer and fall precipitation.

A giant wildcard for climate is the mass of water locked up in the Greenland and West Antarctic ice sheets. Increasing temperatures and greenhouse emissions could cause these ice sheets to melt, or collapse, in a short time. It’s happened in the past. If it happens again, global sea level could rise more than 20 feet in a few centuries.

We could make the big melt less likely by lowering greenhouse gas emissions.