Patuxent River Introduction Sheet

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June 2009

Watershed Total Area= ca. 911 square miles (a different source gives 930 sq. mi; Chesapeake Bay Program gives 957 sq.mi., however the CBP estimate includes ca. 46 sq. mi. south of Lexington Park which drains directly to Chesapeake Bay rather than to Patuxent River proper.) Total length of the "mainstream" Patuxent is about 105.6 miles. Among rivers of the Bay, the Patuxent is 6th in drainage basin/watershed area, 6th in estuarine volume, and 7th in fresh water inflow.

Approximately 25 % of the watershed is Piedmont, 75 % is Coastal Plain, separated by the fall line lying approximately along U.S. Rt. 1 in/near Laurel. The "source" of the Patuxent is on Parr's Ridge near the intersection of Howard, Frederick Montgomery and Carroll counties, about 110-115 miles upstream from the mouth. A USGS flow gage at U.S. Rt. 50 has a drainage area of 348 square miles (38.2 % of the 911 sq. mi. estimate). The head of navigation (originally) was near Queen Anne (Prince Georges County) ca. 52 miles above the mouth, although tidal influence extends another 7 miles upstream. The total basin (911 sq. mi.) was 50.3% forested in 1993.

Anne Arundel	80,526	13.81%
Calvert	102,632	17.60%
Charles	18,086	3.10%
Howard	121,712	20.87%
Montgomery	39,238	6.73%
Prince Georges	159,202	27.30%
St. Mary's	61,687	10.58%

Table 1. Watershed area (acres) and percent distribution among counties.

(A very small fraction of the watershed is in Frederick County.)

Table 2. 1993 Forested areas (total 293, 435 acres; = about 50.3 % of total watershed) and percent distribution among counties.

Anne Arundel	42,433 acres	14.46%
Calvert	75,830	25.84%
Charles	6,970	2.38%
Howard	39,110	13.33%
Montgomery	9,530	3.24%
Prince Georges	80,148	27.31%
St. Marys	39,412	13.43%

Table 3. Subwatersheds, forest cover, stream miles and streamside forest buffering.

Subwatershed, Code number	Subwatershed acres/ % of total watershed	% of subwatershed forested(in ’93)	Stream miles in subwatershed, % Inadequately buffered
Lower Mainstem,02-13-11-01	210,464/36.10%	67.25%	465.46, 70.22%
Middle Mainstem,02-13-11-02	68,653/11.77%	53.18%	188.74, 67.06%
Western Branch,02-13-11-03	59,544/10.21%	38.23%	100.42, 72.18%
Upper Mainstem,02-13-11-04	56,024/9.61%	51.97%	137.89, 65.87%
Little Patuxent,02-13-11-05	66,214/11.36%	41.66%	155.18, 67.66%
Middle Patuxent, 02-13-11-06	37,074/6.36%	31.66%	110.67, 63.7%
Rocky Gorge Reservoir,02-13-11-07	34,598/5.93%	30.03%	98.38, 70.7 %
Triadelphia Reservoir,02-13-11-08	50,512/8.66%	27.3%	161.38, 63.25%

Table 4. Population (2000) by subwatersheds

Subwatershed, Code number	Area, sq. mi.	Population	Pop. Density, No./sq.mi.	Area per person, (Ft. x Ft.)
Lower Mainstem,02-13-11-01 [1]	329	78289 [1, 4]	238	342 x 342
Middle Mainstem,02-13-11-02 [2]	106	27497	259	328 x 328
Western Branch,02-13-11-03	93	119055	1280	148 x 148
Upper Mainstem,02-13-11-04[3]	88-89	106856	1214	152 x 152
Little Patuxent,02-13-11-05	103	181887	1766	126 x 126
Middle Patuxent, 02-13-11-06	58	36560	630	210 x 210
Rocky Gorge Reservoir,02-13-11-07	53-54	26347	497	237 x 237
Triadelphia Reservoir,02-13-11-08	79	14278	181	392 x 392
Total		590769 [5]		

[1] : "Lower Mainstem" EPA designated boundaries are misleading; they include the 46 sq. mi. area south of Lexington Park which drains directly to Chesapeake Bay. This accounts for EPA's total watershed area size of 957 sq. mi. compared to earlier figure of 911 sq.mi.
[2] : "Middle Mainstem": the area including Rosaryville, and contributing Lyons Creek, Mattaponi Creek, Charles Branch, etc.
[3]: "Upper Mainstem": (includes Laurel, Bowie, U.S.Rt. 50/301, Md. Rt. 214.) Actually receives the flows from the farther upstream subwatersheds, including Triadelphia Reservoir, Rocky Gorge, Middle Patuxent, and Little Patuxent, hence it is a discrete subwatershed only for administrative convenience. The total drainage areas above the confluence of western Branch is 382-384 sq, mi.. The 2000 population for that area was about 365,928, or about 61.9 % of the total watershed population on about 42 % of the total watershed area, for a population density of about 955/sq..mi.
[4]:Population estimate is somewhat too high, as it includes the population of that 46 sq. mi.
[5]: EPA population figure for year 2000 does not agree with Md. Dept. State Planning figure of 601, 800.

The watershed's human population more than doubled between 1970 and 2000. State Planning projects a growth of some 25.7% from the year 2000 population (estimated at 601,800) to 756,929 by 2020. Currently, the watershed population is growing at about 1.44 % per year, implying a doubling time of 48 years. This growth, plus smaller households, is projected to increase developed land from ca. 187,439 acres (33 % of the watershed in year 2000) to ca. 255,945 acres (44 % of the watershed) in year 2020. This means that forested land will decrease from 293,435 acres (1993; about 50.3 % of watershed)) to about 189,632 acres, or about 32 % of the watershed. Agricultural land (142,155 acres; ca. 25% in year 2000) will decrease to 115,411 acres (ca. 20 %) in year 2020.

Further, since the upper watershed (subwatersheds -04, -05, and -06) and Western Branch (subwatershed -03) are (and will be) most heavily populated, treated sewage currently makes up from 10.8 to 25.4 % of the May-September average fresh water inflows at the USGS gage at U.S. Rt. 50, and from 24.4 to 54.9 % of the May-September fresh water inflows at Western Branch. Better sewage treatment is now removing more nutrients from the sewage flows. At present, more phosphorus and nitrogen derive from urban non-point sources than from sewage treatment effluents. In 2003, the EPA model estimated (for a "normal" rainfall year) 1,301,000 pounds nitrogen from urban runoff and 1,004,000 pounds from point sources. For phosphorus, the urban load was 101,000 pounds; the point source load was 85,000 pounds.

The Estuary

There are three recognized subsections of the ca. 59 mile long tidal, estuarine portion of the Patuxent River. They are

1. Tidal fresh water . Queen Anne's Bridge to Nottingham (River mile 59 down to river mile ~ 40) Salinities average $\leq$ 0.2 parts per thousand, but can be higher in late Summer/early Fall low flow conditions. From Nottingham down to Chalk Point/Benedict (~ river mile 23), salinities become oligohaline, increasing to near 5.0 parts per thousand (ppt). There are no oysters; this reach is too fresh.. <u>Rangia cuneata</u> brackish water clams are present. This reach and upstream is spawning ground for anadromous herring and shad, white perch, yellow perch, catfish, striped bass. It is nursery area for spot, menhaden, hogchokers. Gizzard shad, sunfish, minnows, largemouth bass are present. Intotal there are about 50 species of fish. It is wintering area for Canada geese, black ducks, tundra swan. Breeding area for wood ducks.

Extensive wild rice marshes, now significantly reduced by resident Canada goose grazing. Wild rice areas have been invaded by and are suffering from competition from the common reed, <u>Phragmites.</u>

Area impacted by erosion and sedimentation from upstream urbanization and suburbanization. From 2005 to 2006, submerged aquatic vegetation (SAV) declined from 324 acres to 204 acres (37 % decline.)

Area contains about 1/2 of the watersheds's 6650 acres of tidal wetlands.

2. Chalk Point/Benedict (river mile 23-24) downstream to Trent Hall Point/Sheridan Point (river mile ~ 19) considered a river-to-estuary transition zone. Salinity range from

oligohaline (less than 5.0 to 5.5 ppt as an annual average) to low mesohaline. Previously had about 8 species of SAV, mostly lost since 1960's; declined from 125 acres to 71 acres from 2005 to 2006 (43 % decline).

Blue crabs and oyster bars present from about Benedict downstream, but the bars are often partially killed out by the two diseases "MSX" (Minchinnia nelsoni) and "dermo" (Perkinsus marinus).

Nursery area for anadromous herrings, white perch striped bass, yellow perch, juvenile menhaden, spot, croaker, weakfish; black ducks, canvasback, scaup present.

3. Trent Hall Point/Sheridan Point (river mile ~ 19) downstream to mouth (river mile 0); considered a mesohaline, lower estuarine sub-embayment/tributary of the Chesapeake Bay. Annual average salinity 12-13 ppt, ranging as high as 18-19 ppt; most SAV lost since '60's, none present in 2005-2006. Heads of some of the larger tributary creeks (e.g., St. Leonard's) have their own tidal fresh zones. Large public oyster bars, e.g., Jack's Bay, Broome's Island, Barngates, Hungerford Hollow, Hawk's Nest, Chinese Muds are present, but have very little production due to the diseases, which typically kill as much as 90 % of the oysters as far upstream as as Battle Creek (Prison Point/Jack's Bay by the time they reach legal size (3") at 2-3 years old. Ca. 57 species of finfish; softshell clams, scaup, canvasback, ospreys, eagles.

Brief Discussion of Patuxent River Ecosystems

The various subecosystems of the Patuxent watershed fall into two different kinds.

A. One naturally tends to evolve towards a stable, semi-steady state, climax condition. This is the terrestrial, originally totally forested system.

(i) It is dominated by numerous kinds of large, old, long-lived, specialized organisms, mostly dominated by trees;

(ii) It typically has comparatively high biodiversity, providing many living pathways for the cycling of materials—carbon, hydrogen, oxygen, phosphorus, potassium, iodine, nitrogen, sulfur, calcium, iron, magnesium, sodium, chlorine—[mnemonic: **C. Hopkins CaFé, M**ighty **g**ood, if taken with a little **salt**]—and the flow of energy through food webs.

(iii) Comparatively very tight, "stingy" control of minerals, nutrients, fixed energy within the community, due to high biodiversity and many specialized, highly efficient living mechanisms of control and exploitation; little runoff of water, little soil erosion;

(iv) Environmental variability, change, fluctuations of temperature, humidity, wind, etc., much moderated, controlled and buffered by living organisms;

(v) Characterized by overall stability, well-buffered against change, difficult to disturb, but once changed severely, requiring a long time (decades) to return to previous state.

B. The second type is one that is harsh, naturally stressed, unsteady, unstable, highly changeable. It never reaches a near steady-state condition. The estuary itself is this kind of situation; everything about an estuary reflects the stresses of frequent, wide fluctuations and change. It is typified by:

(i) dominance by a relatively few species of small, short-lived, “weedy”, generalist opportunistic organisms, such as monocellular algae, micro-sized animals such as zooplankton, relatively few species of large, old, long-lived organisms such as striped bass and oysters

(ii) low biodiversity, relatively few species, each occurring in relatively vast numbers;

(iii) comparatively loose, ineffective control and retention of of materials such as mineral nutrients, which are subject to burial in sediments out of reach of living organisms, or being flushed out to sea;

(iv) instead of relative control of the environment by living organisms, the non-living, abiotic environment—wind, temperature, salinity, tide, topography (particularly shallowness), sediment grain size,--nearly completely controls the living organisms on short-term., day-to-day scales;

(v) characterized by overall community instability; very poorly buffered against change, but adapted to change within the normal range; easy to disturb, but resilient and springs back to previous condition readily, once stresses change;

(vi) however, as a result of having only a relatively few living species pathways for the cycling of materials and the flow of energy, if a few of these are severely reduced, e.g. oysters, SAV, striped bass, menhaden, crabs, emergent wetland vegetation, etc., the whole system becomes subject to wild gyrations such as algae blooms, fish kills, exotic species invasions, dissolved oxygen depression, loss of habitat, etc. It is much like what can happen in a single crop economy, such as a society largely dependent on coffee or bananas.

C. The Patuxent as a whole is a system that has both these ecosystem types in it, linked together by topography, gravity, running water, weather, the influences of the ocean, and resident and migratory living organisms.

The importance of this linkage is that the terrestrial system, when it’s working, stabilizes the estuarine system. The retentive abilities of natural living communities of the Patuxent watershed exert powerful control over water runoff and hence nutrients, minerals and sediment. This ensures that the fluctuations of the estuary do not swing so wildly as to destroy or severely reduce the distribution and abundance of those few living species in the estuary that maintain the flow of materials and energy in pathways which minimize waste of resources and maximize re-cycling and re-use. In terms of what is "desirable" and "useful" from a human viewpoint, such pathways involve such species as oysters, striped bass, eagles, flounders, weakfish, crabs, etc.

D. Image

Think of a sailing ship in a storm. There is no one at the helm, but she's got a sea anchor out to windward, and though she goes wherever the storm takes her, her head stays to the wind, and she rides to the seas with a steady, regular rhythm.

But now suppose that sea anchor is torn, frayed, and full of holes. Now, whenever a wave strikes her, she reels, pitches, shudders and yaws. Her head comes round, she is broadside to the seas, and she rolls heavily, lurching. Her cargo comes adrift inside her hold and pounds at her internal fabric. All her movements are convulsions—short, fast, thrashing and violent, and there is no stability or pattern.

The watershed and its natural living communities are the sea anchor to the estuary. Over 400 years, they have become degraded, converted to the short-term uses of one single species, and they need to be repaired.

What has happened to fray the sea anchor ? What are the problems that the watershed and the estuary are facing ?

As noted above, the watershed's human population more than doubled between 1970 and 2000. State Planning projects a growth of some 25.7% from the year 2000 population (estimated at 601,800) to 756,929 by 2020. Currently, the watershed population is growing at about 1.44 % per year, implying a doubling time of 48 years. This growth, plus smaller households, is projected to increase developed land from ca. 187,439 acres (33 % of the watershed in year 2000) to ca. 255,945 acres (44 % of the watershed) in year 2020.

The percentage of urbanized land in a watershed is strongly related to how healthy or unhealthy stream ecosystems are, how unstable stream banks are, and how well such ecosystems perform their mineral/nutrient re-cycling and retention functions, and thus to how much excessive material they export to the estuary. The amount of ditching and stream channelization, often necessary for flood control because of excessive runoff from impervious surfaces, is related to the lack of, and low diversity of living recycling mechanisms (plants and animals).

This means that forested land will decrease from 293,435 acres (1993; about 50.3 % of watershed)) to about 189,632 acres, or about 32 % of the watershed.

Of 1418 stream miles, about 68% are inadequately buffered by forest.

Agricultural land (142,155 acres; ca. 25% in year 2000) will decrease to 115,411 acres (ca. 20 %) in year 2020.

Under these conditions, the natural result in the estuary is high runoff of water, loss of fertility of the land, erosion of the land and streambanks, sedimentation in the channels, excessive export of minerals and other nutrients from the land to the estuary,

Professor Walter Boynton at UMCES, Solomons, and his colleagues have estimated a nutrient budget for the river,[1] including the amounts of nitrogen and phosphorus coming into the Patuxent from the middle 1980's through the late 1990's, while these conditions were developing and taking effect. Over a 13 years period, through several dry and wet years, the average daily input loading of total nitrogen was about 6,200 kg/day, and that of total phosphorus about 450 kg/day. These daily loads amount to about 2,263,000 kg nitrogen per year, and 164,250 kg phosphorus per year.

The river, including its marshes, water column, sediments and animals holds a total storage of these nutrients of about 2,700,000 kg nitrogen and about 680,000 kg phosphorus. The annual incoming loads and the total storages allow computation of the time required for these nutrients to be "turned over", or recycled. The turnover times are relatively short, being about 1.2 years for nitrogen and 4.2 years for phosphorus. This means that if the incoming loads could be sufficiently reduced, the river should respond positively in a fairly short time.

Dr. Boynton and his colleagues estimate that to achieve dissolved oxygen levels greater than 2 mg/l in deep water, reductions of nitrogen input loads on the order of 1500-2500 kg/day, and, for phosphorus, on the order of 100 kg/day would be necessary.

They further estimated that to reproduce nitrogen loading conditions that prevailed during the 1960's, when seagrasses, benthic life, and oysters were in much better shape, nitrogen inputs would have to be reduced by about 2500-3000 kg/day, i.e., to about half the current daily input loading.

[1]W. R. Boynton & J. D. Hagy & J. C. Cornwell & W. M. Kemp & S. M. Greene & M. S. Owens &J. E. Baker & R. K. Larsen. 2008. Nutrient Budgets and Management Actions in the PatuxentRiver Estuary, Maryland .Estuaries and Coasts. 2008.