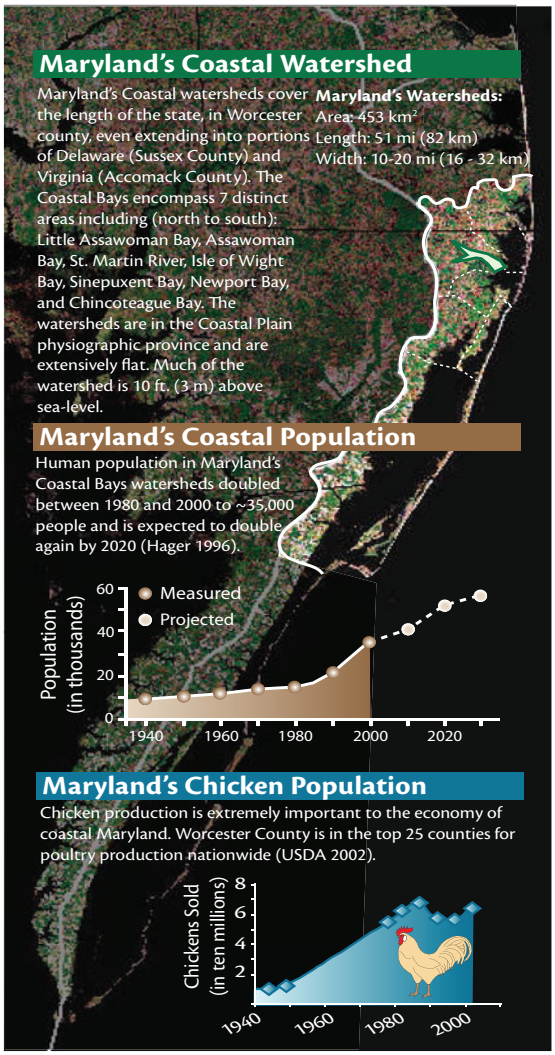
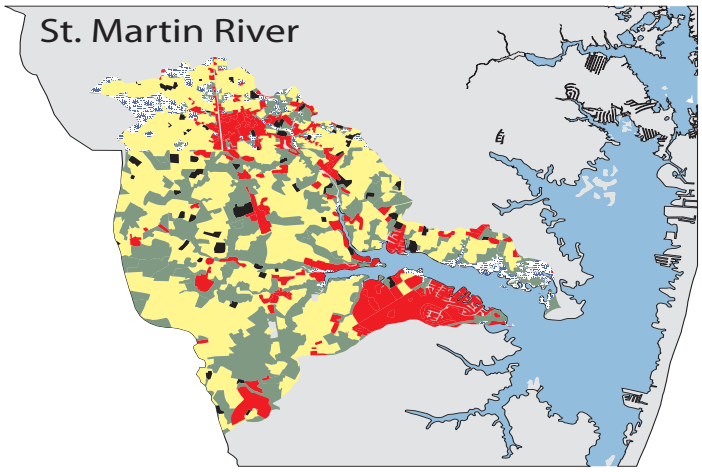
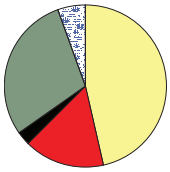
UPSTREAM LAND USE AFFECTS WATER QUALITY IN MARYLAND'S COASTAL BAYS

Coastal lagoon ecosystems across the Delmarva Peninsula are rapidly evolving due to changing land use patterns and shifts towards intensive agriculture, particularly poultry production, and rural-residential development. These changes in the coastal lagoon seascape are especially evident in the northern Coastal Bays watershed of the St. Martin River. This region is intensely developed in areas (e.g. Ocean Pines canal community), is composed of a high percentage of crop agriculture, and contains a number of poultry feeding operations. Water quality degradation continues to be an important issue in this region.





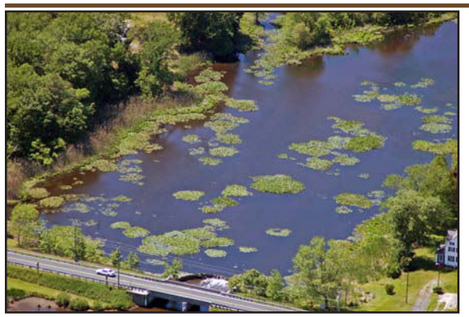


Water area
2,052 acres
(830 ha)

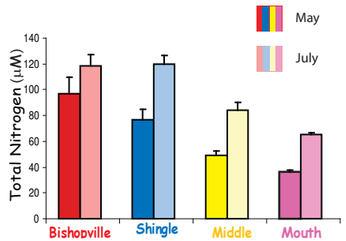
Watershed area
26,022 acres
(10,531 ha)

Feature	Description
Land:water ratio	12.6
Residence time (days)	20-30
Average depth (m)	1.2
Year-round population (year 2000)	9080
Bottom sediment type	clay and silt
Land soil type (from coast to interior)	well-drained to hydric

STRONG WATER QUALITY GRADIENTS IN ST. MARTIN RIVER

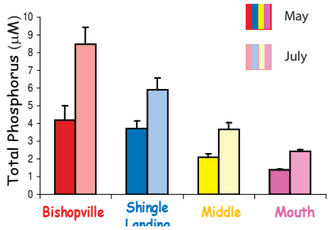


Bishopville Dam increases denitrification



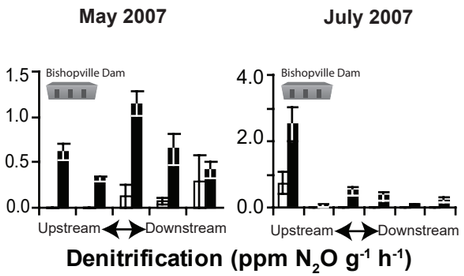
Total nitrogen decreases downstream from the freshwater prongs.

Measurements of total nitrogen and total phosphorus in both upstream prongs of the river were significantly higher than downstream locations in both May and July 2007. Overall concentrations increased from May to July, possibly as the result of regional drought conditions. Nutrient loads were mostly organic, and dissolved inorganic nutrients comprised a very small percentage of both concentrations.



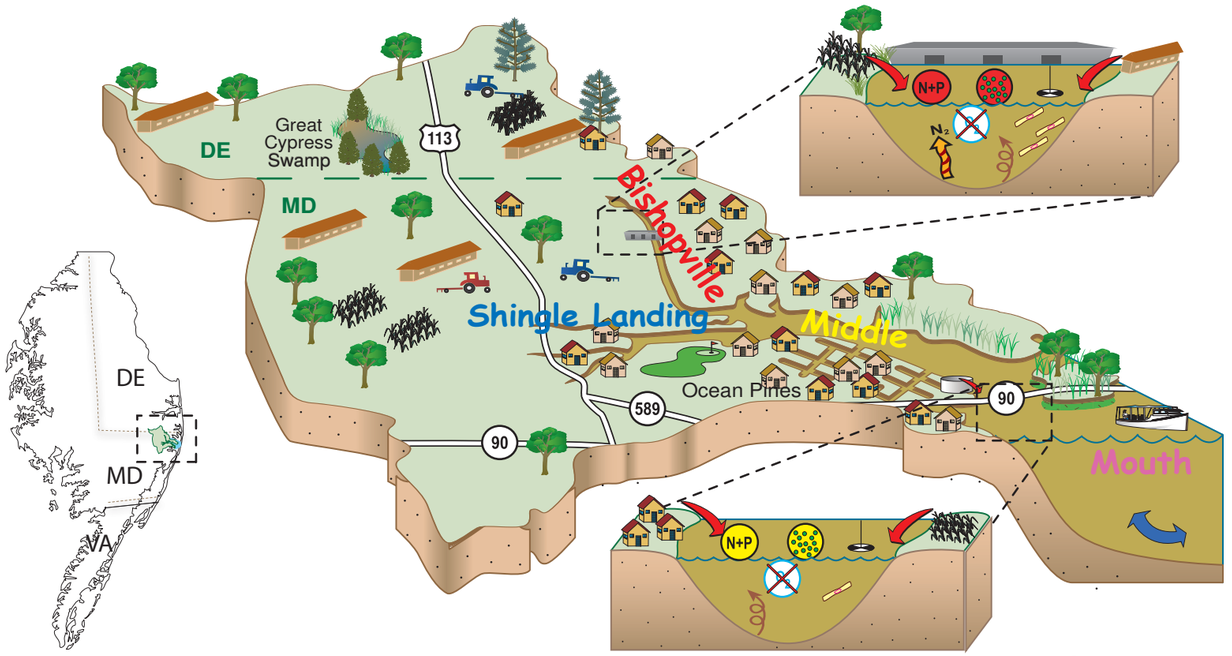
Phosphorus concentrations are highest in upstream sections of the river.

Filtering water for dissolved nutrients in the coastal bays.

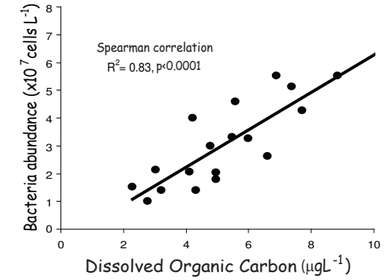


Denitrification, the release of nitrogen to the atmosphere, decreases downstream.

The Bishopville dam marks the uppermost intrusion of saltwater in St. Martin River. Nutrients and sediments from agriculture and residential areas above the dam impact water quality. High denitrification, which converts accumulated nitrogen in sediments to innocuous N_2 gas, was observed at the dam. Rates of denitrification throughout St. Martin River remained low in May, but were significantly increased in July. In the near future, the dam will be removed, which will likely affect downstream water quality.



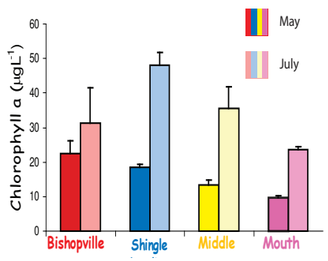
St. Martin River is freshwater-fed by the Shingle Landing and Bishopville Prongs. Inputs of nitrogen and phosphorus (N+P) from feeding operations and crop agriculture above the Bishopville dam lead to high concentrations of bacteria, chlorophyll a, decreased Secchi depth, sediment resuspension, low dissolved oxygen, and high rates of denitrification. These measurements decrease through the Middle of the River towards the Mouth, where inputs come mainly from urban and crop land and are diluted by



Bacterial abundance and dissolved organic carbon are strongly correlated.

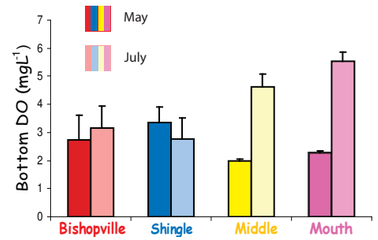
Naturally occuring bacteria in the St. Martin River provide an important link in the food web and impact nutrient cycling. Samples taken in different sections of the river revealed that high organic nutrient concentrations are concurrent with bacteria, decreasing towards the mouth. Abundances are similar to those in nutrient-enriched systems such as the Chesapeake Bay. Bacteria abundance displayed a strong correlation with dissolved organic carbon.

The mouth of St. Martin River, looking out towards the barrier islands.

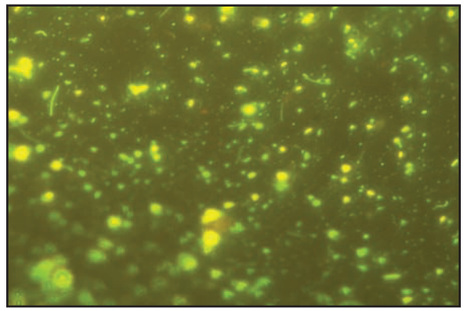


Chlorophyll concentrations were highest in upstream sections.

Both freshwater prongs of St. Martin River had high concentrations of chlorophyll *a*, especially in July. Chlorophyll *a* showed a trend of decreasing concentration downstream. Low dissolved oxygen, resulting from a combination of the degradation of phytoplankton, increased temperature, and limited circulation, was also observed upstream. Dissolved oxygen was higher towards the mouth of the river. These patterns were most likely observed as the result of tidal flushing and lower nutrient inputs in the downstream reaches.

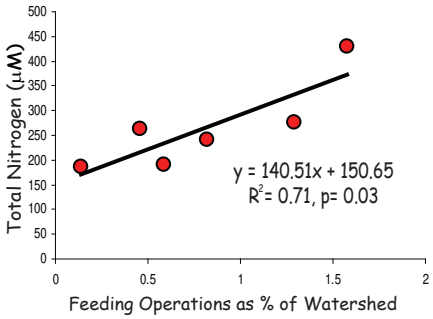


Dissolved oxygen remained low throughout 2007.



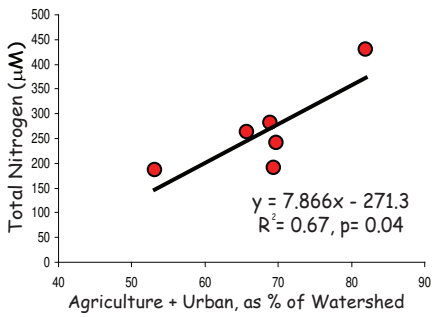
Bacteria and viruses of St. Martin River, stained using the SYBER Green method

RELATING LAND USE TO NITROGEN



Significant positive relationship between area of feeding operations and stream total nitrogen concentrations

Crop agriculture is the dominant land use in St. Martin River watershed.



Significant positive relationship between anthropogenic land use (agricultural and urban) and total nitrogen concentrations

An assessment of total nitrogen concentrations in six streams of the St. Martin River watershed during high-flow months (2006-2008) revealed distinct relationships to land use. Although feeding operations comprised less than 2% of the sub-watershed areas of the streams, total nitrogen displayed a significant positive relationship with this form of land use. Similarly, agricultural and urban land use had a significant positive relationship with total nitrogen, indicating that human landscape modification is increasing nutrient concentrations and degrading overall water quality of the St. Martin River watershed.

CONCLUSIONS

- Land use pressures contribute to water quality degradation in St. Martin River.
- Spatial patterns reveal high nutrient concentrations in upstream areas.
- High chlorophyll and low dissolved oxygen result from high nutrient inputs.
- The Bishopville dam may enhance denitrification and accumulate nutrients.
- Land use, especially feeding operations, is linked to high nitrogen concentrations.

RECOMMENDATIONS

- *Focus* on ameliorating land use runoff to improve water quality.
- *Target* upstream areas for monitoring nutrient loading.
- *Examine* links between nutrients, feeding operations, and nutrient management.
- *Consider* consequences of removing the Bishopville dam, especially nutrient release.
- *Preserve* natural land cover (wetlands and forest) as critical in reducing nutrient inputs.

References:

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