NUTRIENT INPUT MANAGEMENT, BENTHIC PHOTOSYNTHESIS, AND RESTORATION OF SHALLOW EUTROPHIC COASTAL ECOSYSTEMS

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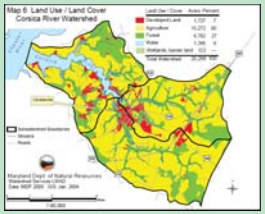
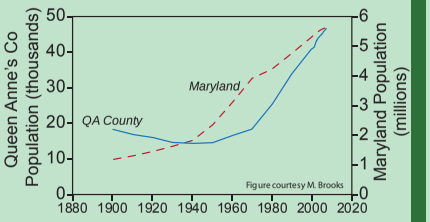
Introduction to Corsica River Restoration

- The Corsica river estuary is a highly degraded tributary of the Chester River in the Chesapeake Bay system
- Recent efforts by the state of Maryland have made restoration of the Corsica River an example for future bay-wide restoration
- A key to the restoration is identifying what nutrient sources need to be reduced and by how much to improve water quality in the estuary

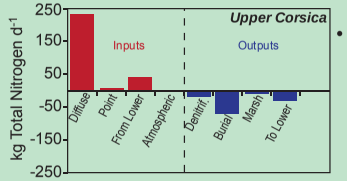
Nutrient Flows Connect Humans with Corsica Estuary



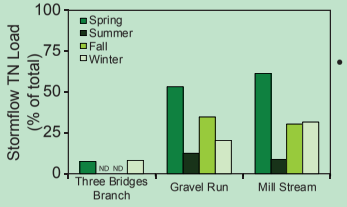


- Corsica River watershed is dominated by agricultural land
- Nutrient (Nitrogen & Phosphorus) losses from farm fields are the biggest source to Corsica estuary
- Nutrients also come from septic systems, lawns, city streets, atmospheric deposition, and sewage treatment plants
- Nutrient loads have increased during the last 50 years with population growth and changing agriculture

Major Nitrogen Sources and Sinks for the Corsica

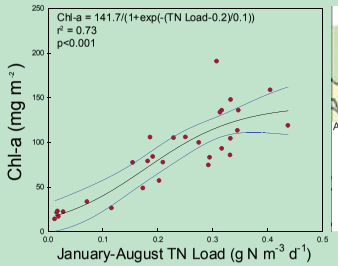


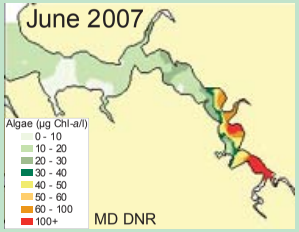
- A total nitrogen (TN) budget indicates that N inputs from the watershed are the major source, while N removal via burial & denitrification



- N loads during storm events comprise 25-50% of TN loads during most seasons in the 3 major tributaries of the Corsica

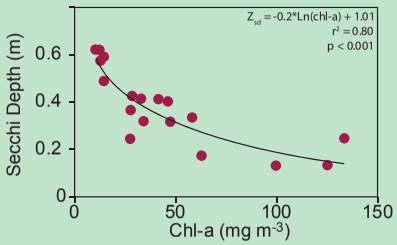
Nitrogen Loads Linked to chlorophyll-a in the Estuary





In the Corsica River, chl-a peaks occur in the upper estuary (right figure)
Summer chl-a is linked to spring-summer nitrogen loading for many shallow Chesapeake Bay estuaries (left figure)
The N load-chl-a relationship indicates non-linear dynmaics, but more data are needed to characterize TN load effects on chl-a

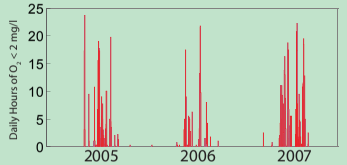
Elevated chl-a Decreases Water Clarity



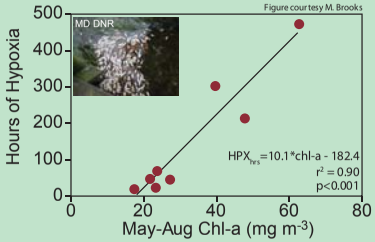
- Chl-a appears to be the primary driver of light attenuation during warm months in the upper and lower estuary
- Thus, it appears that the paradigm of elevated nutrient loading causing increased water column chl-a and reduced water clarity is true for the Corsica River estuary

High chl-a Linked to Hypoxia Duration

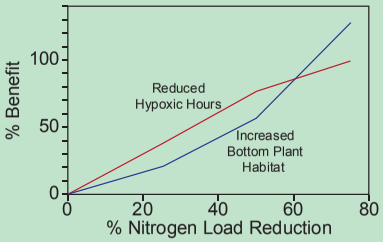
- Hypoxic events occur in surface waters during night hours in the Corsica during summer months



- The duration of hypoxic events is linked to chl-a concentrations
- Prolonged low oxygen events can cause fish kills in the Corsica and other estuaries



Simple Model of System Responses to Reduced N Loads

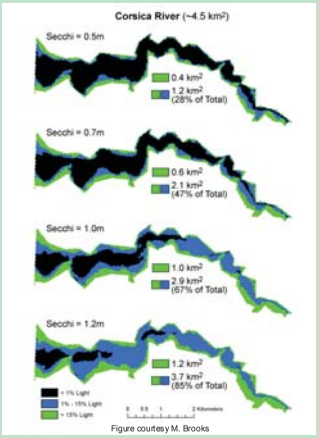


A simple model relates TN load to chl-a and chl-a to both hypoxic hours and sediment plant habitat via regression relationships shown above

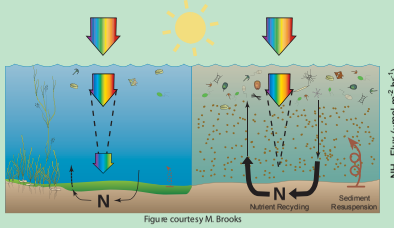
Reducing TN loads will improve water clarity and restore bottom plants
It will also improve oxygen conditions and restore animal habitat
A large part (30 - 50%) of TN load is from direct runoff, therefore watershed N management should have immediate effects
Because the Corsica is shallow, small improvements in water clarity may allow sediment plant growth to accelerate further restoration

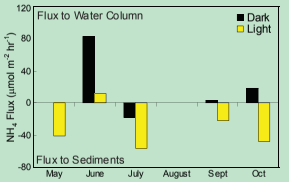
Small Increases in Water Clarity Greatly Increase Area of Photic Sediments

- By reducing chl-a enough to increase Secchi depth by 0.5 m (0.5 to 1 m), ~70% of Corsica sediments could support bottom plants (algae or vascular plants)
- This suggests that small reductions in chl-a may yeild large increases in sediment area that could that could support photosynthesis



Increased Area of Photic Sediments May Trap Nutrients





- Benthic photosynthesis has been shown to reduce sediment-water nutrient fluxes (e.g., Tyler et al. 2003 L&O V48, Sundbäck et al. 2004 L&O V49)
- Corsica sediments switched to a net N sink when exposed to light (right figure)
- This indicates the potential for non-linear chl-a declines with TN load reduction via the following sequence (see also left figure):

(1) Initial TN load declines reduce chl-a → *(2) Reduced chl-a improves water clarity* → *(3) Improved water clarity allows more light to sediments* → *(4) Light to sediments promotes N retention via benthic algal growth* → *(5) Sediment N retention will ↓ N fluxes to water column and further limit algal growth*

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