Cost-Effectiveness Comparison of Floodplain Wetland Restoration

as a Best Management Practice for nutrient and sediment abatement in the Chesapeake Bay Watershed

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Cost Effectiveness Analysis

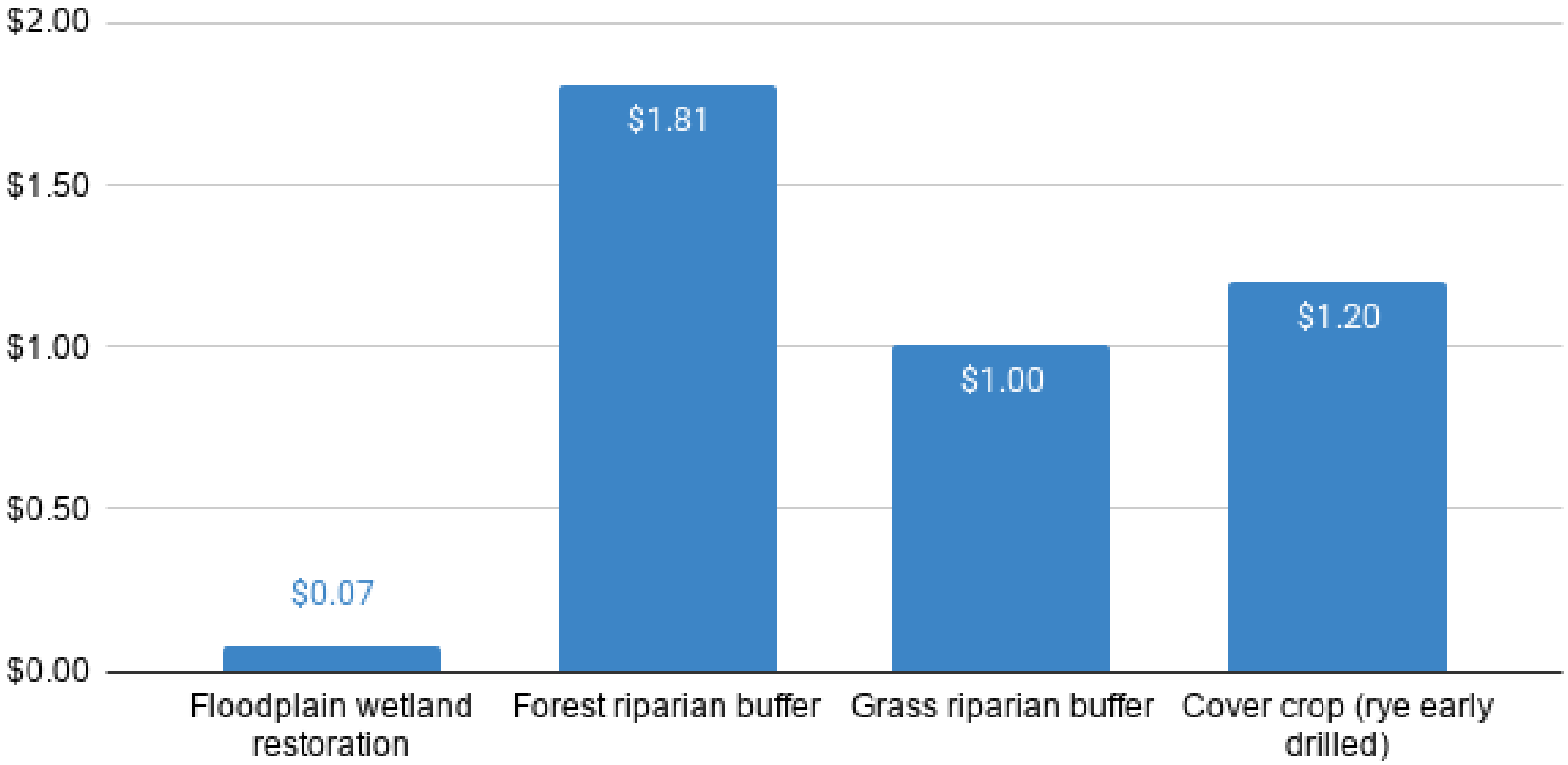
image: Flaticon.com

2019 WSI report

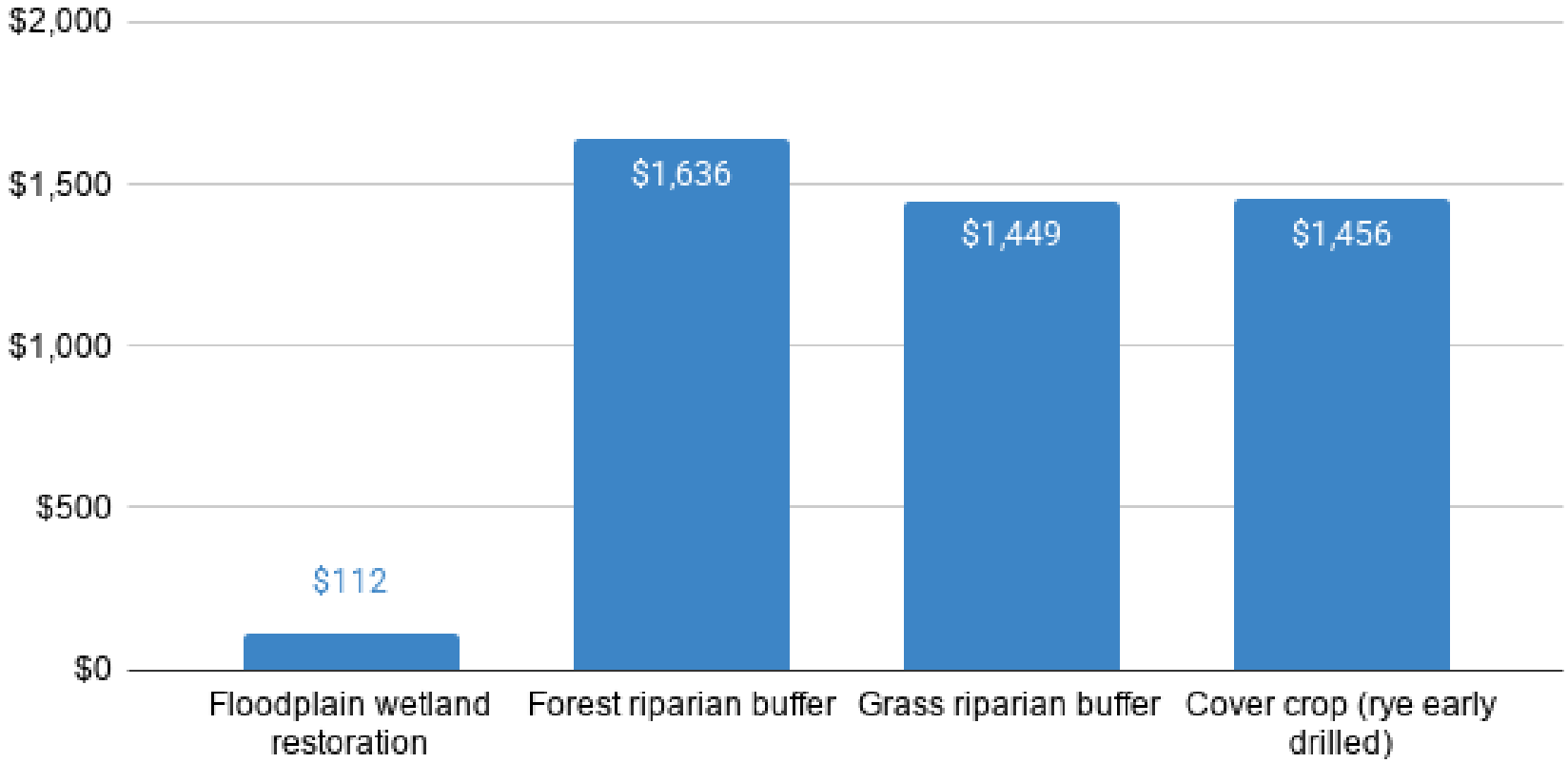
- Lowest cost way of achieving a desired policy goal, given limited resources
- Best management practices (BMPs)
- Costs / Abatement ($/lb)
  - Abatement - the quantity of reduction of a pollutant
    - Sediment, phosphorus, nitrogen
- Update of Fleming 2019 report
- Results overview, methodology, takeaways

Farm fields border the lower Susquehanna River as it flows into the Chesapeake Bay at Havre de Grace, Maryland. *Photo: Will Parson/Chesapeake Bay Program.*

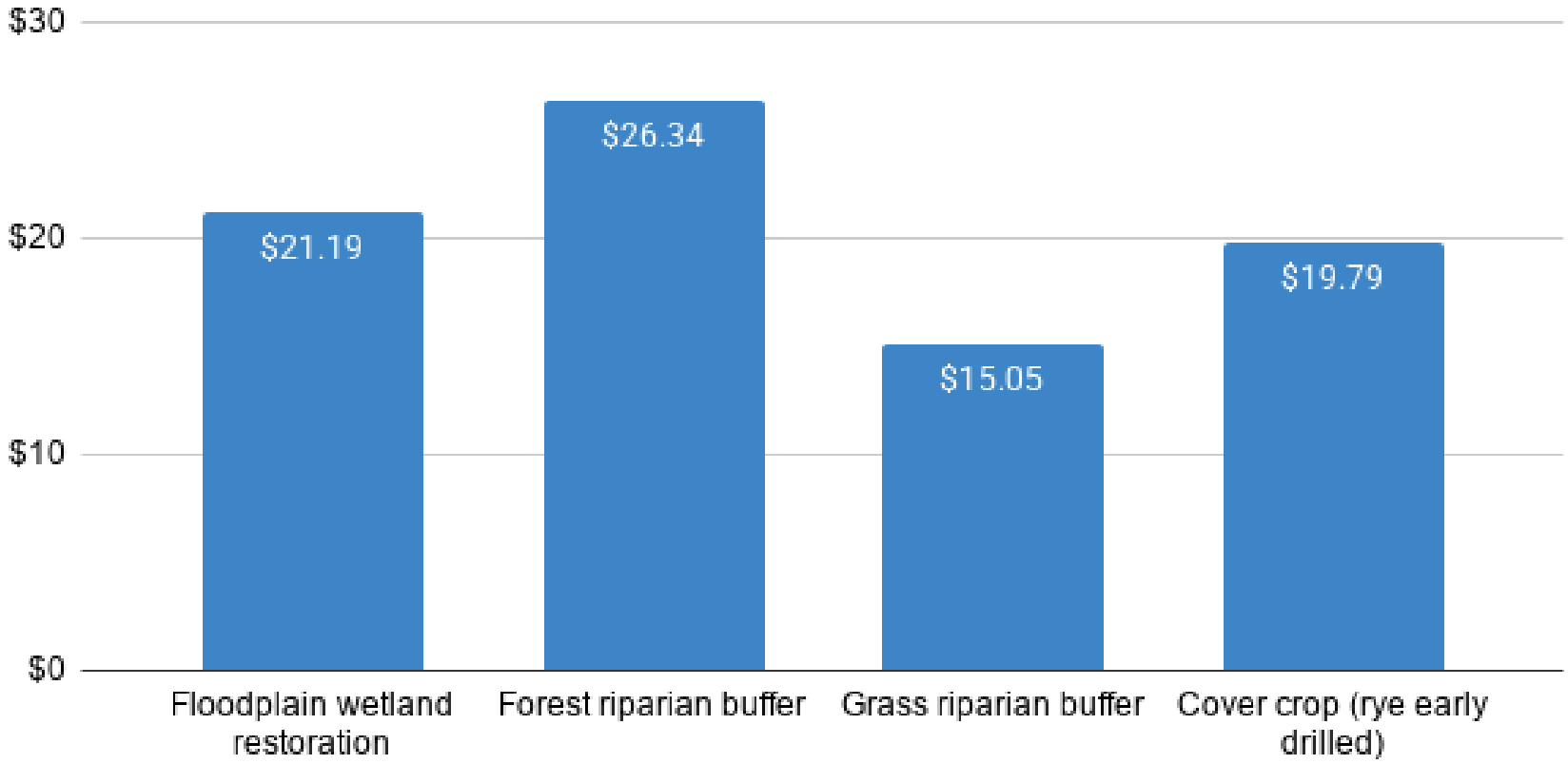
$/lb Sediment Reduced by Best Management Practices (BMPs) in Pennsylvania at the Edge-Of-Tide



$/lb Phosphorus Reduced by Best Management Practices (BMPs) in Pennsylvania at the Edge-Of-Tide



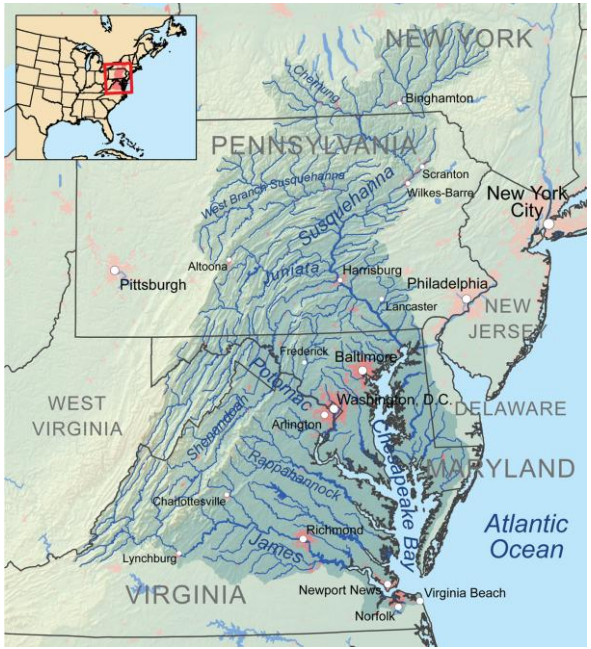
$/lb Nitrogen Reduced by Best Management Practices (BMPs) in Pennsylvania at the Edge-Of-Tide



Chesapeake Assessment Scenario Tool (CAST)

- Primary model used by the *Chesapeake Bay Program* & *EPA* to credit projects and track progress toward Chesapeake Bay goals
- External planning use
- Modeled data
  - Abatement
  - Costs

Chesapeake Bay Program
Science. Restoration. Partnership.



The Chesapeake Bay watershed.
Credit: Kmusser, Wikipedia.

Abatement Calculations: Agricultural BMPs

- CAST
  - Modeled abatement
  - Pennsylvania state level
  - Per acre per year
- Loads on land use types
  - Prior: grain with manure

An early stage forest riparian buffer.
Photo: Sarah Hagan.

- Riparian buffers
  - Land use change (source)
  - Filtration of upland acres
- Cover crops
  - Filtration of working-land acres (%)

Rye cover crop. *Photo: United Soybean Board.*

Abatement Calculations: Wetland-Floodplain Restorations

- From a PA based environmental engineering firm
  - Calculated for permitting
  - 11 projects in Lancaster, Franklin, Lebanon, & York counties
- CAST stream restoration protocols
  - Engineering data
  - Protocols 1, 2, & 3
    - 1 - Prevented erosion Sediment
    - 2 - Hyporheic Denitrification
    - 3 - storm event Floodplain Pollutant Trapping
- Conversions
  - Per acre
  - Delivery ratios
    - What percentage of pollutant loads at a project reach The Bay?

A restoration site in Lancaster, Pennsylvania.

Components of Costs

- Implementation costs
- Maintenance & monitoring costs
- Opportunity costs
  - *"Prime farmland"* soil rental rate * 2

Credit: iStock: Nomadsoul1

Source: netsuite

- Conversions
  - Per acre, per year
  - 2025 dollars
    - Producer Price Index
      (Federal Reserve Bank of St Louis)

Costs: Agricultural BMPs

- Riparian buffer opportunity costs
  - Cover crops - none
- Implementation costs from CAST
- Annualization - riparian buffers
  - Contract length
    - 10 years for grass
    - 15 years for forest
- Forest riparian buffer maintenance
  - Labor costs
    - 20 hours (per acre per year) for 5 years
    - *agricultural managers* - $31.05/hr *(NASS)*

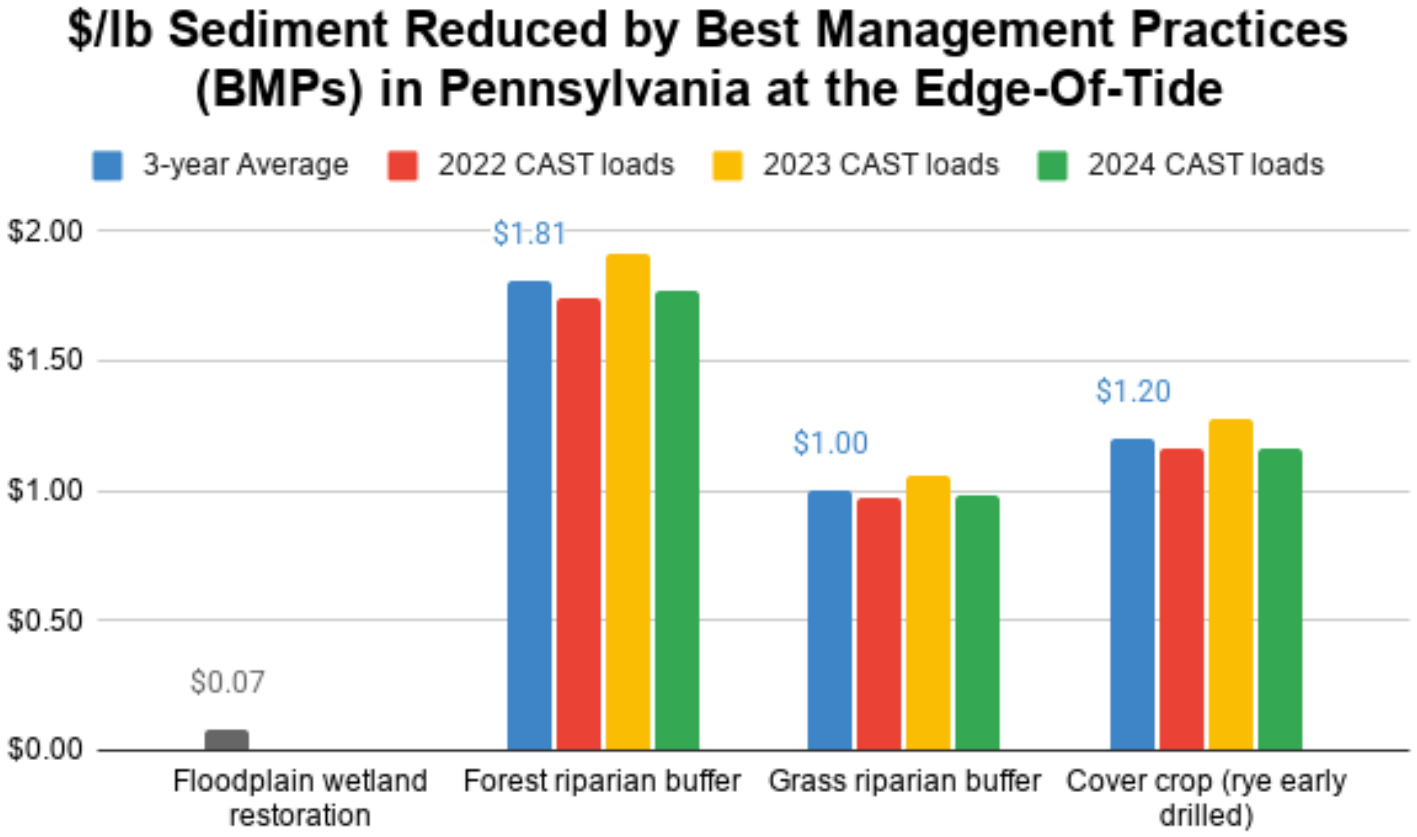
Credit: iStock: simazoran

Costs: Wetland-Floodplain Restorations

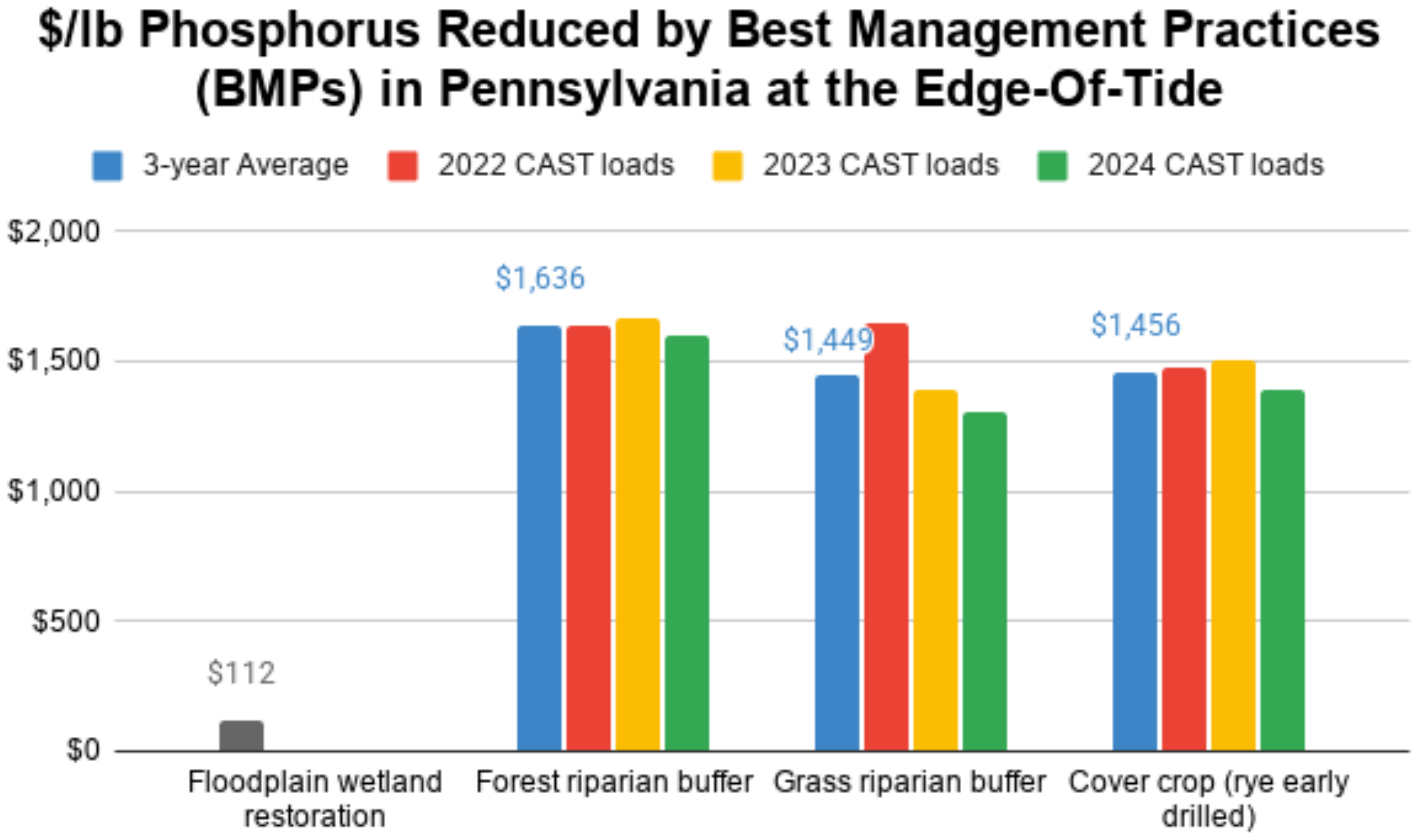
- Opportunity costs
- Actual upfront project construction costs
- 5-year Maintenance & Monitoring (M&M)
- Annualization in perpetuity
  - Value of present day costs every year into the future
  - Calculated using a 2% discount rate

Machinery working during the construction of a restoration in Millersville, Pennsylvania.

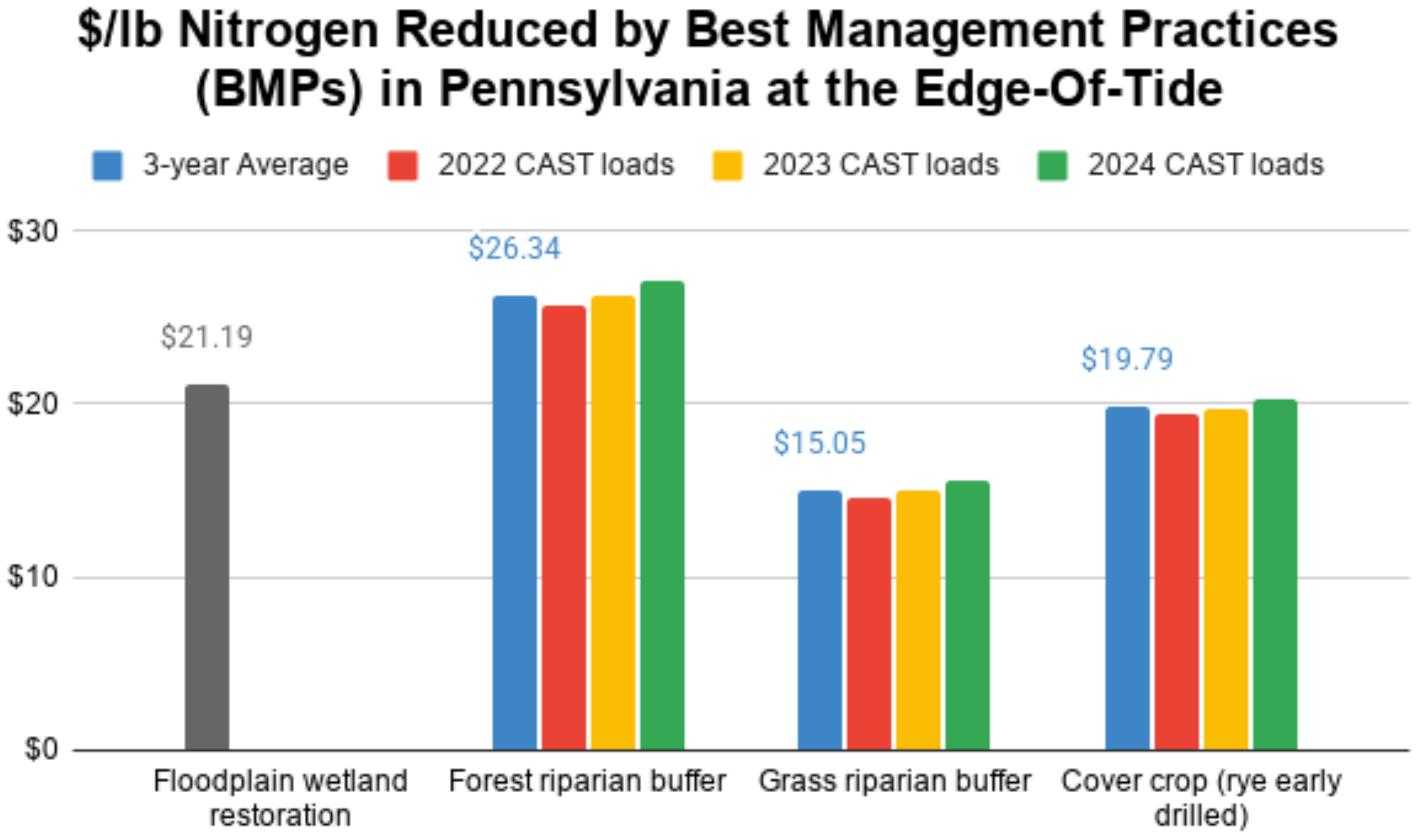
14x more cost effective for sediment abatement



13x more cost effective for phosphorus abatement



Cost competitive for nitrogen abatement



Restoration Cost Effectiveness: Modeled vs Monitored

- Big Spring Run
  - 2019 report costs
    - Updated for inflation
- Sediment
  - Modeled average $0.07/lb
  - Monitored $0.04/lb
- Phosphorus
  - Modeled average $111.72/lb
  - Monitored $24.12/lb
- Nitrogen
  - Modeled average $21.19/lb
  - Monitored $17.68/lb

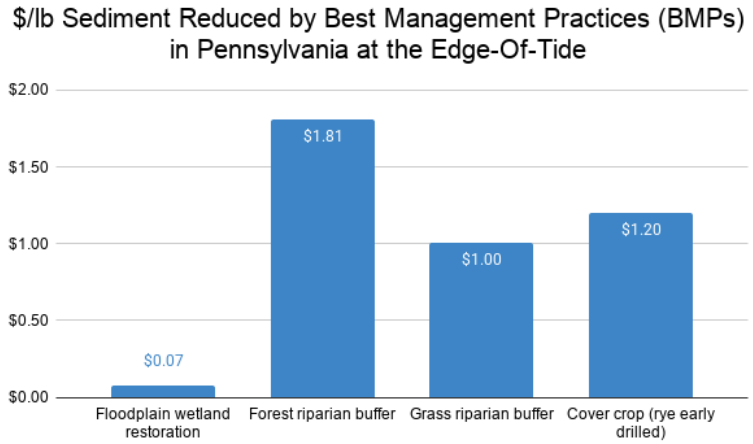
The USGS gage station at Big Spring Run in Lancaster, Pennsylvania.

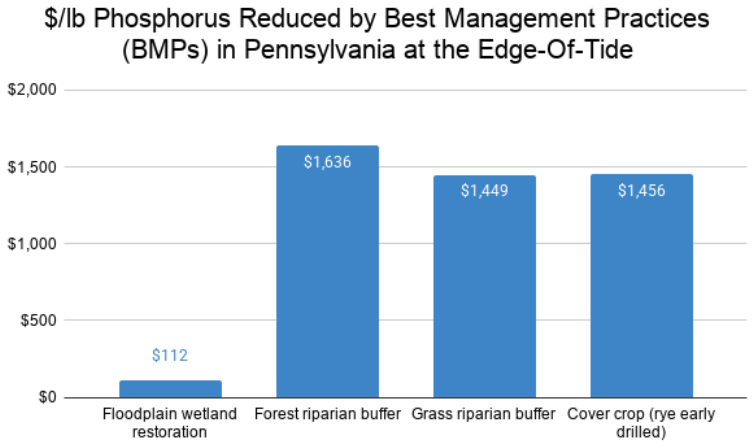
Next Steps

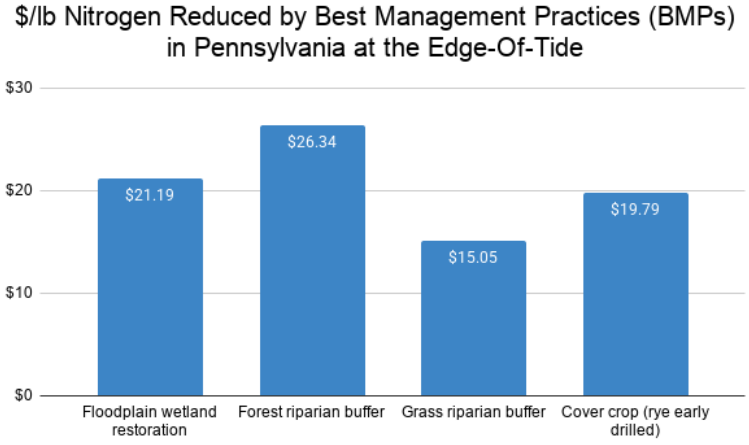
- Actual riparian buffer costs from NRCS payment schedules
- Robustness Checks
  - Varied discount rates
  - Varied agricultural land uses (CAST)

USDA NRCS
U.S. Department of Agriculture
Natural Resources Conservation Service

Manure is applied to a grain field. *Photo: OSU extension.*


$/lb Sediment Reduced by Best Management Practices (BMPs) in Pennsylvania at the Edge-Of-Tide
$2.00
$1.50
$1.00
$0.50
$0.00
$0.07
$1.81
$1.00
$1.20
Floodplain wetland restoration
Forest riparian buffer
Grass riparian buffer
Cover crop (rye early drilled)


$/lb Phosphorus Reduced by Best Management Practices (BMPs) in Pennsylvania at the Edge-Of-Tide
$2,000
$1,500
$1,000
$500
$0
$112
$1,636
$1,449
$1,456
Floodplain wetland restoration
Forest riparian buffer
Grass riparian buffer
Cover crop (rye early drilled)


$/lb Nitrogen Reduced by Best Management Practices (BMPs) in Pennsylvania at the Edge-Of-Tide
$30
$20
$10
$0
$21.19
$26.34
$15.05
$19.79
Floodplain wetland restoration
Forest riparian buffer
Grass riparian buffer
Cover crop (rye early drilled)