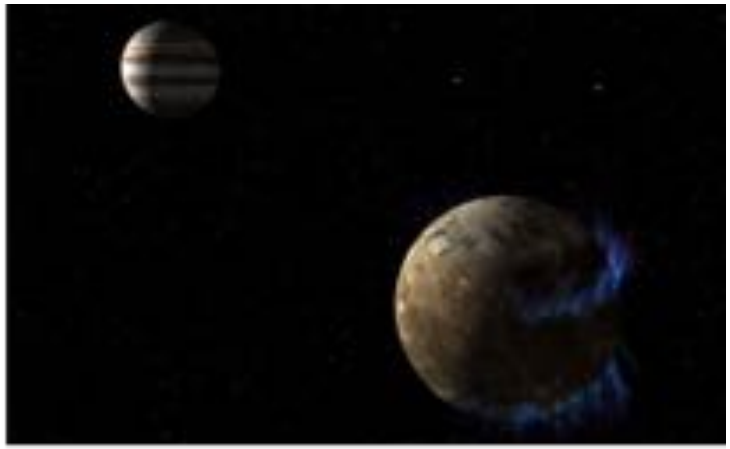
50th Anniversary of the Delaware Water Resources Center

2015 Annual Meeting
Newark, Del.
April 17, 2015

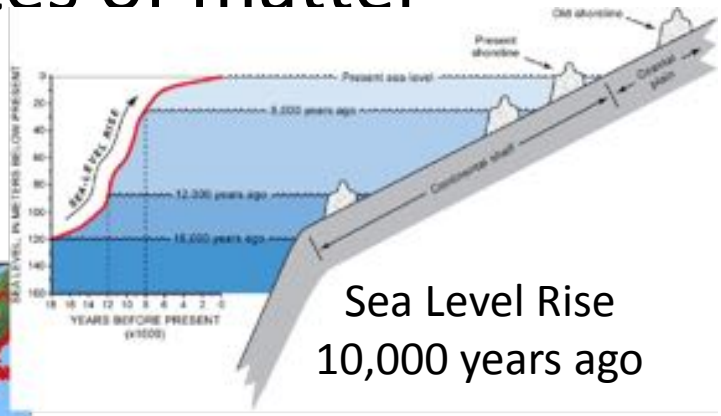
Gerald J. Kauffman, Ph.D., Director
University of Delaware
Water Resources Center

NIWR
THE NATIONAL INSTITUTES FOR WATER RESOURCES

Water



- 97-3-1
- Essential for life
- Most precious chemical (H_20)
- Universal solvent
- Exists in nature as all three states of matter
- No economic substitute



DRBC Compact
1961 AD

LYNDON B. JOHNSON

XXXVI President of the United States: 1963-1969

461 - Statement by the President Upon Signing the Water Resources Research Act.

July 17, 1964

THE Water Resources Research Act of 1964, which I have approved today, fills a vital need.

Abundant, good water is essential to continued economic growth and progress. The Congress has found that we have entered a period in which acute water shortages are hampering our industries, our agriculture, our recreation, and our individual health and happiness.

Assuming a continuation of current practices, by the year 2000 there will not be enough usable water to meet the water requirements of parts of the States of Arizona, California, Colorado, Delaware, Idaho, Illinois, Indiana, Iowa, Kansas, Louisiana, Michigan, Minnesota, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Dakota, Texas, Utah, Wisconsin, and Wyoming.

This legislation will help us solve this problem. It will create local centers of water research. It will enlist the intellectual power of universities and research institutes in a nationwide effort to conserve and utilize our water resources for the common benefit. The new centers will be concerned with municipal and regional, as well as with national water problems. Their ready accessibility to State and local officials will permit each problem to be attacked on an individual basis, the only way in which the complex characteristics of each water deficiency can be resolved. The bill contemplates a high degree of interstate cooperation, and I urge that this be encouraged.

In large measure, this legislation is a tribute to the vision and wisdom of Senator Clinton P. Anderson of New Mexico. He has long recognized the problems. He developed the program. He guided it through Congress. He has been in the forefront of the effort to see that adequate supplies of water are available in all parts of the Nation.

The Blue Hen. Newark, Del.: University of Delaware, 1965.

CLOSE

Delaware Water Resources Center
at the University of Delaware

DWRC

Undergraduate Internships
In Water Resources 2015

University of Delaware | College of Agriculture & Natural Resources

Delaware Water Resources Center (DWRC) Undergraduate Internships in Water Resources provide a unique opportunity for undergraduate students and faculty to become directly involved in research and education projects addressing water resource related issues of critical importance to Delaware and the Mid-Atlantic region.

Eligibility

[illegible]

Program Details and Deadline

[illegible] http://ag.udel.edu/dwrc/

Delaware Water Resources Center (DWRC) interns

[illegible]

The DWRC Internship Program

[illegible]

Delaware Department of Natural Resources and Environmental Control [illegible]

Topics in water resources research and education of interest to the DWRC:

[illegible]

How to Apply for a DWRC Internship

[illegible]

Delaware Water Resources Center

Gerald J. Kauffman, Ph.D., Director
DGS Annex 261 Academy Street
Newark, DE 19716
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E-mail: jerryk@udel.edu

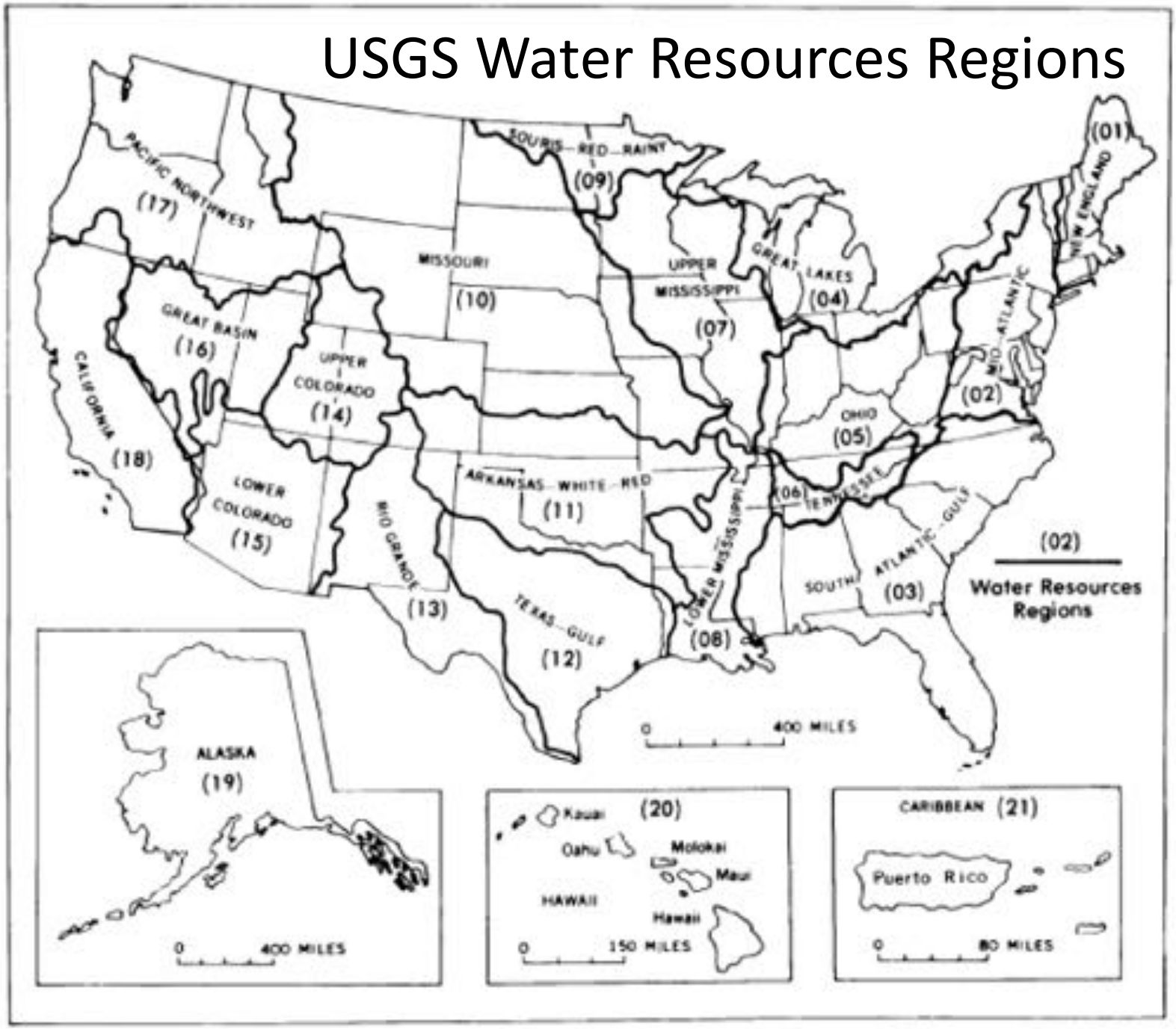
Member Agency:

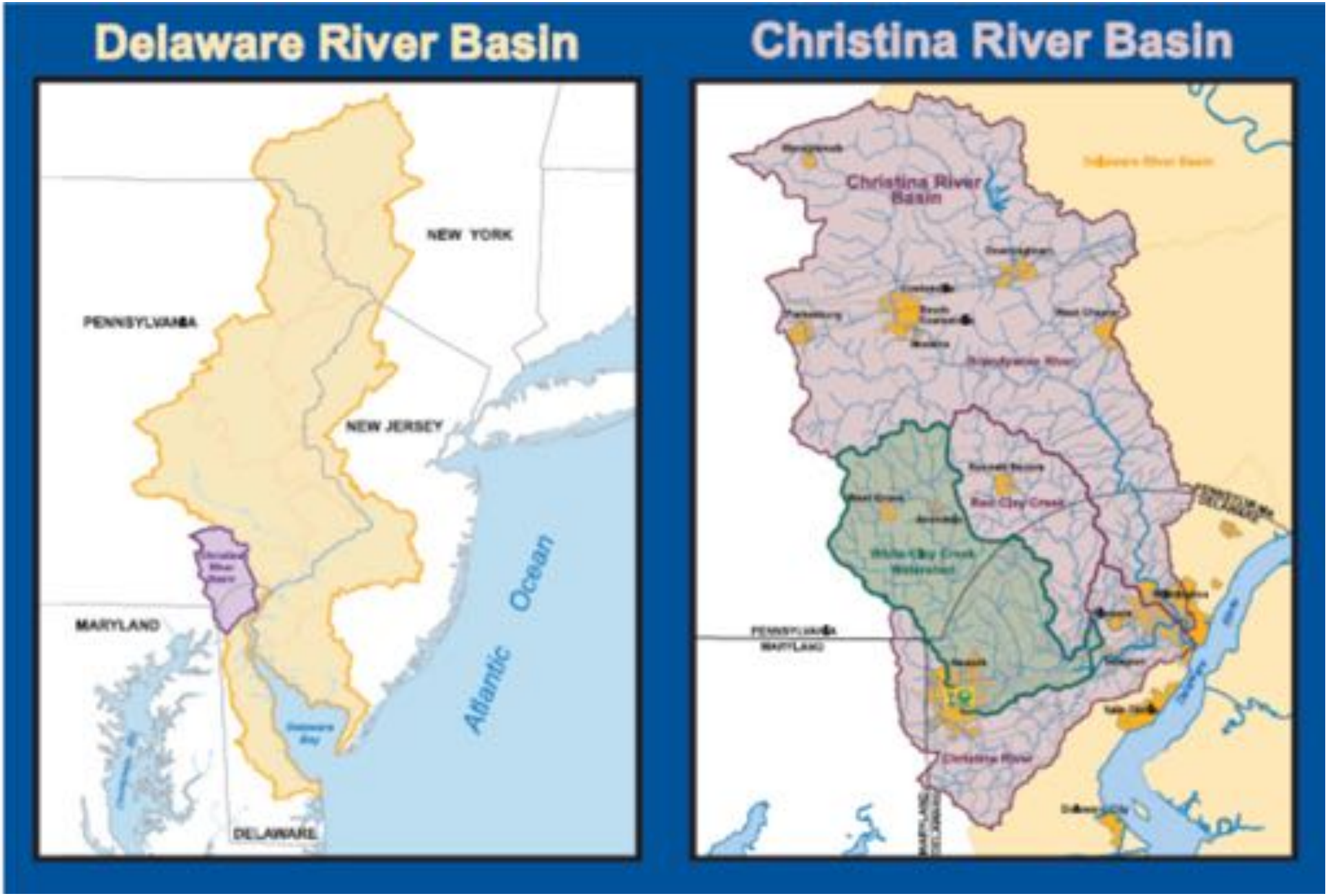
NIWR

Photo by Danielle Quigley

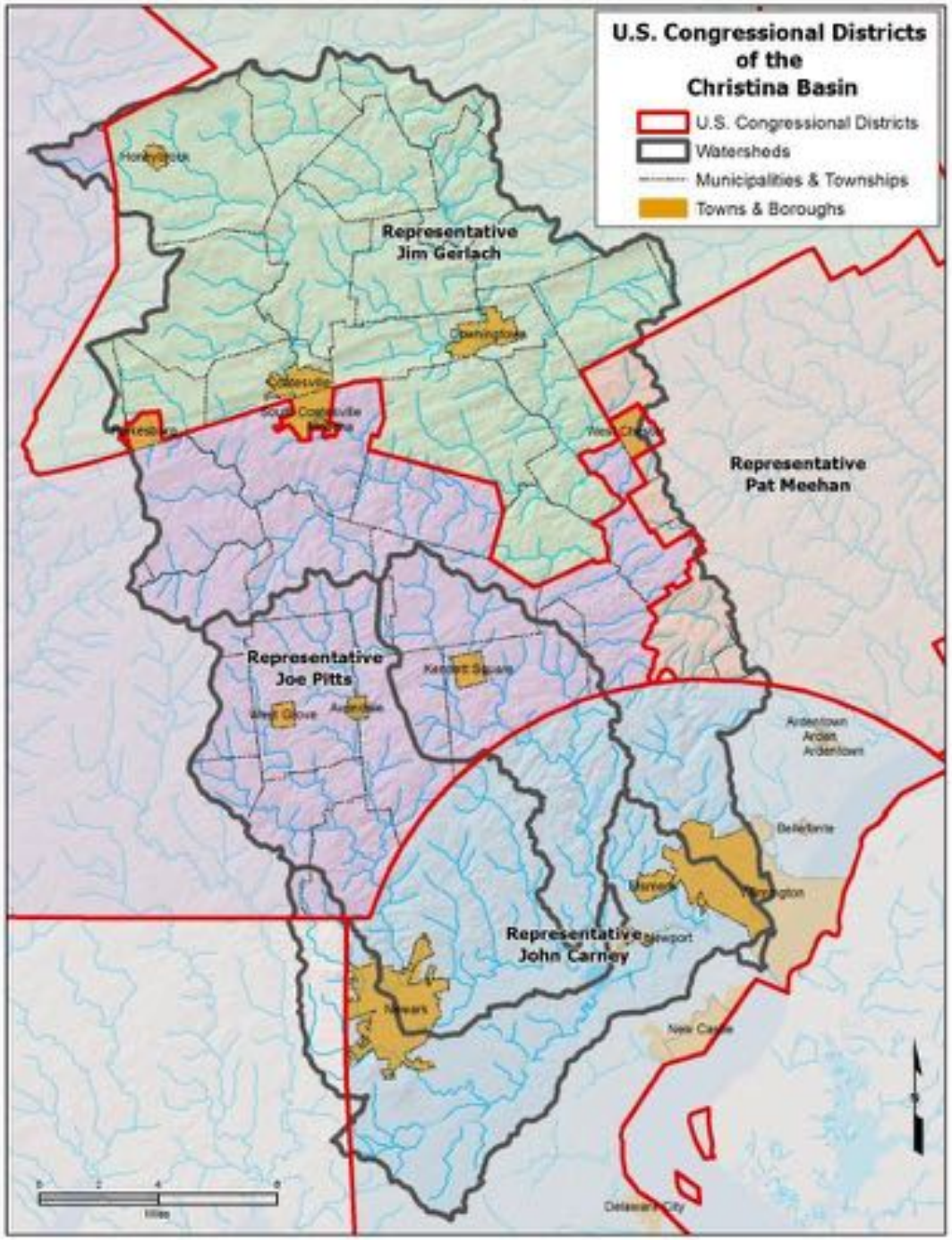
http://ag.udel.edu/dwrc/

USGS Water Resources Regions





The University of Delaware is fortuitously situated on campuses ideally suited by hydrology and geography to study water resources.


U.S. Congressional Districts of the Christina Basin
U.S. Congressional Districts
Watersheds
Municipalities & Townships
Towns & Boroughs
Representative Jim Gerlach
Representative Pat Meehan
Representative Joe Pitts
Representative John Carney
Newark
Wilmington
Delaware City
Miles

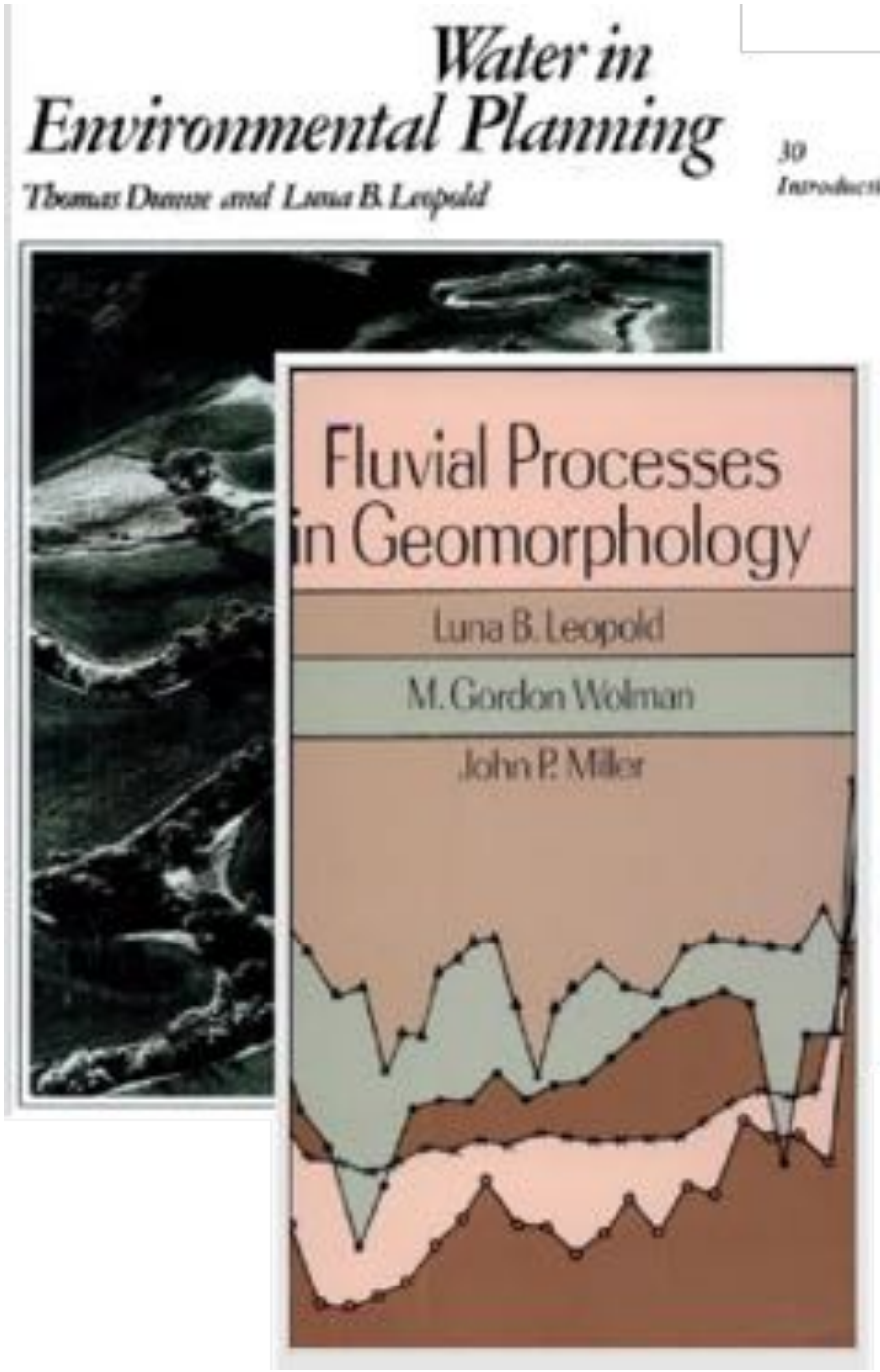
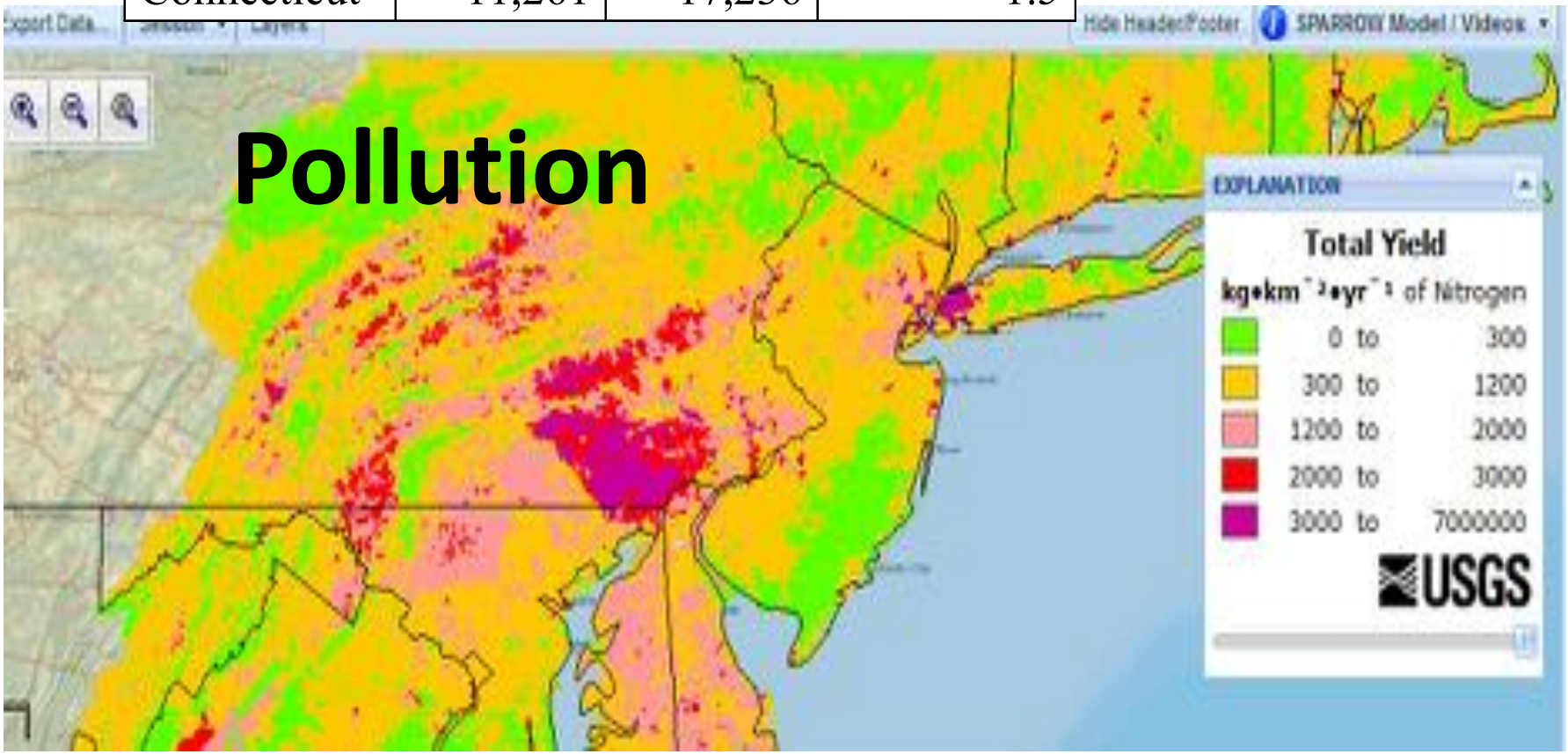


Figure 1-17 Load of soluble and insoluble phosphorus passing stations on the East Branch of the Brandywine Creek, August 13–14, 1973. Numbers are in kilograms of phosphorus per day. Hatched areas are towns and villages. (Modified after Cahill et al. 1975.)

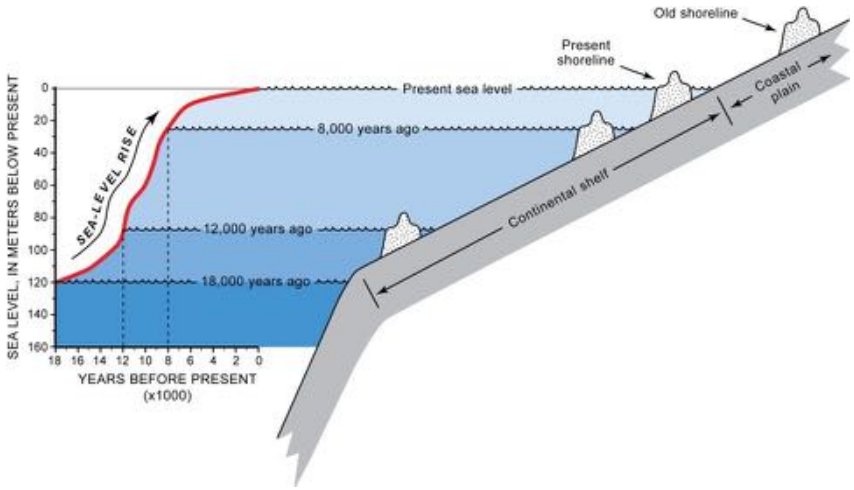
River Basin	Drainage Area (mi^2)	Nitrogen Load (ton/yr)	Unit N Load ($ton/mi^2/yr$)
Susquehanna	27,490	73,040	2.7
Delaware	11,819	50,525	4.3
Potomac	14,658	44,707	3.0
Hudson	13,363	28,711	2.1
James	10,339	17,482	1.7
Connecticut	11,261	17,236	1.5



Sea Level Rise

Delaware
Mean elev. 60 ft msl

Figure 1. Sea level rise and coastal flooding impacts in Delaware (NOAA Coastal Services Center)



10,000 years ago

Research Activities of the Delaware Water Resources Center

Creating a Floodplain Wetland to Protect Water Quality in the White Clay Creek National Wild and Scenic River Watershed

*UD Project Team: UD WATER (Watershed Action Team for Ecological Restoration)**

Watershed Management Practices

College of Agriculture & Natural Resources Farm (2006-2011)

Creating a Floodplain Wetland

Background: The Cool Run tributary of the White Clay Creek drains land on the UD campus and in the City of Newark. It has long been negatively impacted by nonpoint pollution from urban, industrial, and agricultural sources and is listed by the US EPA as an impaired water body for nutrients, dissolved oxygen, bacteria, and sediments. In 2006, the UD WATER team analyzed stormwater pollutant loads in the Cool Run Watershed and recommended increasing the number and acreage of wetlands in the watershed to improve water quality and ecosystem health.

Project: A section of low quality pasture was removed from agricultural use to create a healthy, functioning floodplain wetland, thus reducing pollutant load to the White Clay Creek by filtering stormwater runoff. This wetland, along with others created on the farm, will also create stormwater storage, important to prevention of downstream flooding. This project illustrates how the University partners with the City to manage land in the White Clay Creek watershed in a manner that improves water quality. Wildlife habitat will be created and enhanced, increasing the diversity of species on the farm and campus, an important component of UD efforts to be a more sustainable university.

Funding: Provided by the **UD Sustainability Fund**, the **College of Agriculture and Natural Resources**, and the **Department of Natural Resources and Environmental Control (DNREC)**

Wetland Construction and Status:

- ✓ Wetlands ecological design developed by DNREC
- ✓ Permits obtained from state and federal agencies
- ✓ Land adjacent to stream channel excavated, lowering it and creating pockets with openings to the stream.
- ✓ During storms, water rises higher in the stream channel and can now flow into the excavated acreage and pond in the low areas. In this way, water is "stored", allowing it to evaporate or infiltrate and thus reducing storm flows downstream.
- ✓ The combination of hummocks and pockets of differing depths also creates a varied habitat for wildlife. While some native flora will be planted, the wetland will naturally fill in with native vegetation.

How Wetlands are Constructed

Heavy earthmoving equipment used to excavate to create "microtopography" – shallow ponded areas and hummocks of different depths.

Large, aged logs and stumps may be added to create habitat.

Native trees, shrubs, and grasses are planted for additional habitat.

Wetland plant species begin to colonize the ponded areas naturally.

After the constructed wetland area takes a few years to fill in and become naturalized, wildlife moves in right away.

Stormwater Solutions for the University of Delaware's North Campus: Hydrologic Modeling in the Piedmont Watershed

Jillian Allen, Tim D'Agostino, Hannah Diehl
UD Watershed Action Team for Ecological Restoration (UD WATER)

1. Introduction

Stormwater runoff is an increasing problem for the health of water quality and water supply in the White Clay Creek National Wild and Scenic River. The Land campus, in the Piedmont, at the University of Delaware contains a large amount of impervious cover which increases runoff and pollutant loads detrimental to the White Clay Creek (Fig. 1). Reduction of impervious cover through best management practices such as rain gardens and reforestation will reduce the detrimental impact of stormwater on the quality of White Clay Creek.

2. Research Objectives

To reduce runoff and pollutant loads, develop a watershed model to determine how changes in the stormwater system will improve water quality and reduce flooding in: (1) Fairfield Run, (2) Blue Hen Creek, (3) a gully system tributary to White Clay Creek.

3. Methods

Each watershed was modeled using an EPA hydrology/hydraulics program called SWMM (Storm Water Management Model). The SWMM model was developed according to the following methods:

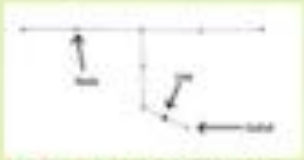
Task 1 - Delineate the watersheds (Fig. 2) into appropriate sections according to topography (contour lines) and the stormwater network using GIS data. This was done using GIS data and for time and convenience sake was prepared for us.

Task 2 - Create a backdrop map for the SWMM model that includes the subcatchments, pipes, and outfalls that convey the stormwater runoff.

Task 3 - Input nodes (manholes) and outfalls to create the framework of the SWMM model (Fig. 3).

Task 4 - Connect the nodes and outfalls using links (stormwater pipes) as depicted in Fig. 4.

Task 5 - Define and draw the catchments on the map to complete the basic watershed model (Figs. 5, 6, 7).



4. Results

The gully system has the following parameters:
1. Area: 14 acres
2. Links: 37
3. Nodes: 36
4. Outfalls: 7

4. Results

Fairfield Run has the following parameters:
1. Area: 139.4 acres
2. Links: 61
3. Nodes: 66
4. Outfalls: 5

Blue Hen Creek has the following parameters:
1. Area: 246.3 acres
2. Links: 133
3. Nodes: 134
4. Outfalls: 16

5. Future Work

1. Input rainfall data collected from the field to run the model.
2. Watershed data such as area, pipe diameter and length, and invert elevation must be put into the model.
3. Run the model with alternate inputs (such as BMP's installed).
4. Expansion of the SWMM model to include the entire University of Delaware campus and Newark.

6. Acknowledgements

We would like to acknowledge our mentors Gerald Kauffman and Andrew Homsey for all of their help throughout the course of this project. We would also like to thank the WSA for the funding for this project.

Sustainable UD water

WATERSHED ACTION TEAM FOR ECOLOGICAL RESTORATION

Hydrologic Response from a Developed Piedmont Watershed

Kate Ankenbach[1], Virginia Thornton[2*], Luc Claessens[3], Gerald Kauffman[4]
[1]University of Delaware, Department of Environmental Engineering
[2]University of Delaware, Department of Energy and Environmental Policy
[3]University of Delaware, Department of Geography
[4]University of Delaware, Water Resources Agency

1. Introduction

Stormwater runoff has the ability to erode Earth's surface, causing channels to form along its path from impervious areas to streams, rivers, etc. Large channels, known as gullies, can be examined to determine the extent of the effects of stormwater. The resulting analysis can also provide insight into the implementation of appropriate stormwater management practices.

2. Objectives

- For gullies located in a Piedmont watershed:
  - (1) Quantify total suspended solids loads received over time.
  - (2) Determine temporal probable peak flows.

(Above) Photographs of the three gullies being analyzed within this study: 2013.

3. Methods

- Data representing Pre-1292 (completely forested), 1937, 1954, 1961, 1968, and 1992 land development and stormwater management conditions were analyzed in this study. The three sites examined in this study are located near Newark, DE within the Christiana River Watershed and shown above.
  - (1) Land use data generated by ArcGIS was combined with annual precipitation estimates and mean pollutant concentrations in the Simplified Method in order to determine the total suspended solids pollutant load each sub-watershed has experienced over time.
  - (2) Within the TR-55 Hydrology Model, land use data was processed with time of concentration data to produce the expected 2-, 10-, and 100-year storm flows associated with each year and watershed being examined.

4. Key Results

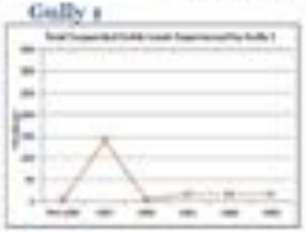
Sub-Watershed Delineation Results

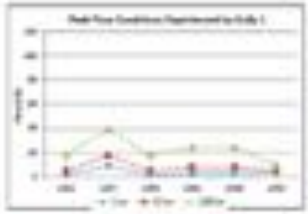
Figure 1. Aerial photographs from 1937, 1954, 1992, and 2010 containing the sub-watershed delineation for each gully. 1968 aerial photograph omitted due to lack of variation from 1961 land use.

- Significant land use and stormwater management development occurred between the years 1937 and 1992.

Pollutant Load and Peak Flow Analysis Results

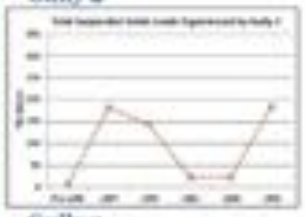
Gully 1

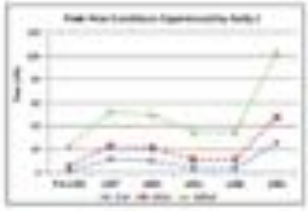




- Increase in both modeled TSS load and flow during the year 1937 correlate to peak in farming society and agricultural land.
- Comparatively low TSS values are due to the small size of the watershed characterizing Gully 1.

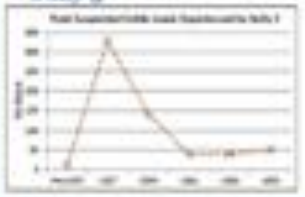
Gully 2

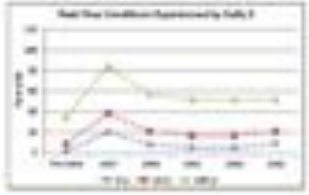




- Rise in both TSS load and peak flow in 1992 corresponds to increase in watershed boundary associated with Gully 2 due to the installation of a sewer system and large parking lot depicted on 1992 aerial photograph.

Gully 3





- Relatively large predicted values for TSS load and peak flow experienced by Gully 3 in comparison to 1 and 2 correspond to the size of its watershed boundary in relation to those of Gullies 1 and 2.

5. Conclusions

The results of this study demonstrate that:

(1) Because TSS loads and peak flows are functions of land use, graphical results for each parameter over time exhibit the same shape.

(2) Severe increases in predicted loading and flow can be resultant of:
  - (a) Increases in appearance of specific high nutrient- and/or high metal-containing land use (i.e., agriculture, parking lots).
  - (b) Increases in sub-watershed size due to changes in flow patterns (i.e., introduction of sewer system).

6. Future Work

- Conduct field studies in order to:
  - (1) Increase the accuracy of the models.
  - (2) Compare model results to actual data.
- Perform spatial survey on each gully in hopes of:
  - (1) Classifying them further.
  - (2) Obtaining data to serve as input into more advanced hydrologic modeling/prediction system (i.e., HEC-RAS).

7. Acknowledgements

This project was funded by the University of Delaware's Watershed Action Team for Ecological Restoration through the Delaware Water Resource Center and completed under the guidance of the entire UDWATER team with special assistance from Jennifer Pyle (EHS), and Andrew Homsey (WRA).

Sustainable UD water

WATERSHED ACTION TEAM FOR ECOLOGICAL RESTORATION

Assessment of Forest Quality Along an Urban-Rural Transition in a Piedmont Watershed

Megan R. Shaffer[1], Devika P. Banerjee[2], Luc Claessens[3], Gerald J. Kauffman[4]

[1]Biological Sciences [2]Environmental Studies
[3]Department of Geography [4]Water Resource Agency

1. Introduction:

The University of Delaware currently owns forests in the White Clay Creek State Park that protect the surrounding watershed. This study sought to assess the forest quality and habitat health of these forests, which occur in a zone of urban-rural transition. These lands have previously been used for agriculture but today have reverted back to deciduous and evergreen forest, presently shaped by urbanization and development.

2. Methods:

We conducted a field survey of the university owned forest and assigned ratings in a comparative fashion of poor, fair and good based on criteria provided by Kaddy and Drummond (1996) and the Delaware State Park Division of Parks and Recreation Trail Committee (Table 1). Maps based on our findings were constructed using GIS and compared to forest types from previous land use data from Delaware DataMIL. Areas were estimated from Google Earth.

Table 1. Summary of forest quality categories (poor, intermediate, fair) with a description of each level of health.

Forest Quality Category	Qualifying Factors
POOR	Small trees Density of understory brush [illegible] density of canopy species High percentage of invasive species
FAIR	Intermediate sized trees Density of understory brush [illegible] density of canopy species Mid percentage of invasive species
GOOD	Large trees Density of understory brush [illegible] density of canopy species Low percentage of invasive species

3. Results:

Forest Quality	Area (in m²)
POOR	[illegible] m²
FAIR	[illegible] m²
GOOD	[illegible] m²
TOTAL	[illegible] m²

Forest Type Observed	Estimated Area (in m²)
Evergreen	[illegible] m²
Deciduous	~24,000 m²
Mixed	~45,500 m²

Table 2. Qualitative findings of forest survey.

Area Assessed	Grade	Characteristics
Forest behind the Laird campus towers to the south of Fairfield Run Stream	Poor	[illegible]
Forest north of the Fairfield Run Stream to the Fairfield Run Watershed boundary	Fair	[illegible]
Remaining forest surrounding the Fairfield Run Watershed	Good	[illegible]

4. Conclusions:

For future studies, a quantitative analysis of (1) tree diameter and height, (2) density of understory species, (3) density of canopy species, and (4) percentage of invasive species per area would allow for a statistical comparison of the health of these forest regions assessed.

A future forest restoration plan is needed and would not only allow for the return of these poor forest areas to healthy conditions, but also would preserve the good regions. Recommended activities for this plan include: controlling and removing invasive plants; planting native vegetation in open spaces; pruning young trees to promote greater tree health; and other appropriate maintenance to allow optimal health of trees.

5. Acknowledgments:

We would like to thank UD WATER and the Delaware Water Resource Center who provided funding to make this project possible. In addition, we would like to thank [illegible] for their support and guidance. Lastly we would like to acknowledge the other interns, [illegible] for their help with GIS work and access to the DataMIL.

6. References:

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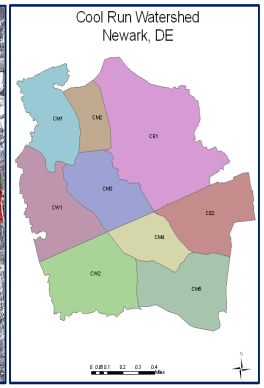
Sustainable UD water

WATERSHED ACTION TEAM FOR ECOLOGICAL RESTORATION



Reference Collection Categorized by Order and Family:

Sampling completed by undergrad Bonnie McDevitt during the Summer of 2010

Order	Family
Non Insects:	
Annelida	Hirudinea
Basommatophora	Physidae
Haplotaxida	Tubificidae
Veneroida	Sphaeriidae
Insects:	
Coleoptera	Dytiscidae
Coleoptera	Scarabaeidae
Coleoptera	Hydrophilidae
Diptera	Chaoboridae
Diptera	Stratiomyidae
Diptera	Syrphidae
Diptera	Chironomidae
Diptera	Culicidae
Diptera	Tipulidae
Ephemeroptera	Baetidae
Hempitera	Gerridae
Hemiptera	Belostomatidae
Hempitera	Corixidae
Hemiptera	Veliidae
Hemiptera	Mesoveliidae
Hempitera	Notonectidae
Odonata	Aeshnidae
Odonata	Coenargrionidae
Odonata	Libellulidae

Delaware Water Resources Center
UD WATER Project 2010 – 2011
Melanie Allen
Advisor: Dr. Judith Hough-Goldstein
Area of Campus Studied: South Campus

UD WATER - Project Goals

The goals of the UD WATER project were – for the UD Campus:

(1) Identify major nonpoint sources of pollution in the Cool Run Sub-watershed of the White Clay Creek (a wild and scenic river with tributaries on the campus)

(2) Estimate, using USEPA methods and average pollutant concentrations in runoff, the annual pollutant loads to the Cool Run tributary from different land uses5

(3) Develop recommendations to improve stormwater management, reducing flooding and improving water quality in the White Clay creek watershed

Personal Project Goal:

(1) Create a reference collection of the biodiversity of aquatic macroinvertebrates in the UD Experimental Watershed at Newark Research and Education Center of the University of Delaware College of Agriculture and Natural Resources from samples collected during the Summer of 2010. (credit to Bonnie McDevitt) for future interns to utilize as a baseline of data.

(2) Complete a Winter sampling to add to the reference collection.

Locations of Sampling completed on March 2, 2011 by Melanie Allen

Site 1: located on one of the Cool Run tributaries that travels through agricultural land containing dairy pastures and cropland
Site 2: located along Old South Chapel Street near the intersection with Farm Lane.
Site 3: located near the power transfer station where one of the Cool Run tributaries crosses under the Amtrak access road.
Site 4 located next to the Amtrak tracks as Cool Run tributary enters UD property.
Site 5: :located at the east end of the cattle pasture on the Webb Farm.
Site 6 : located on the east side of Route 72 near the entrance to the Webb Farm.

Methodology:

I followed a protocol for sampling aquatic macroinvertebrates in freshwater wetlands developed by the Maine Department of Environmental Protection. When sampling, I used the dip net measured sweep, which is the primary method used to collect aquatic macroinvertebrates in wetlands. A micron D-frame net is swept against the bottom substrate three times to remove and collect organisms from the sediment, keeping sure that the net is submerged during the entire sweep. All of the collected material is transferred into a sieve bucket, where water is drained and materials were transferred into individual specimens containers filled with ethyl alcohol, where they would be preserved until identification.

Results:

Negative. Found little to no biological biodiversity.

This was potentially due to the time of year as well as low oxygen levels. The Protocol practiced by the Maine Department of Environmental Protection that I followed recommended completing sampling during June-July, however due to time restraints I was only able to get a sampling in early March when specimens were minute or dormant. During early summer, aquatic invertebrate are much more developed and easier to identify. Dissolved oxygen analysis measures the amount of gaseous oxygen (O2) dissolved in a water solution. Below is a comparison of Dissolved Oxygen levels measured in mg/L from the Summer of 2010 and March 2011 (Table 1). The oxygen levels for a majority of the sites was lower in March, influencing its ability to support life.

Sources:
McCafferty, Patrick. *Aquatic Entomology: The Fishermen's and Ecologists' Illustrated Guide to Insects and Their Relatives.* Science Books International. Boston, Massachusetts. 1981.
Dept. of Environmental Protection: State of Maine. Protocols for Sampling Macroinvertebrates in Freshwater Wetlands: Division of Environmental Assessment Biological Monitoring Program

Table 1

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
June	1.64	5.94	10.41	10.01	8.90	5.83
July	7.29	5.43	9.48	9.69	7.95	6.22
August	7.88	6.82	9.57	10.12	10.59	7.77
March	0.87	6.71	8.58	7.94	7.20	6.27

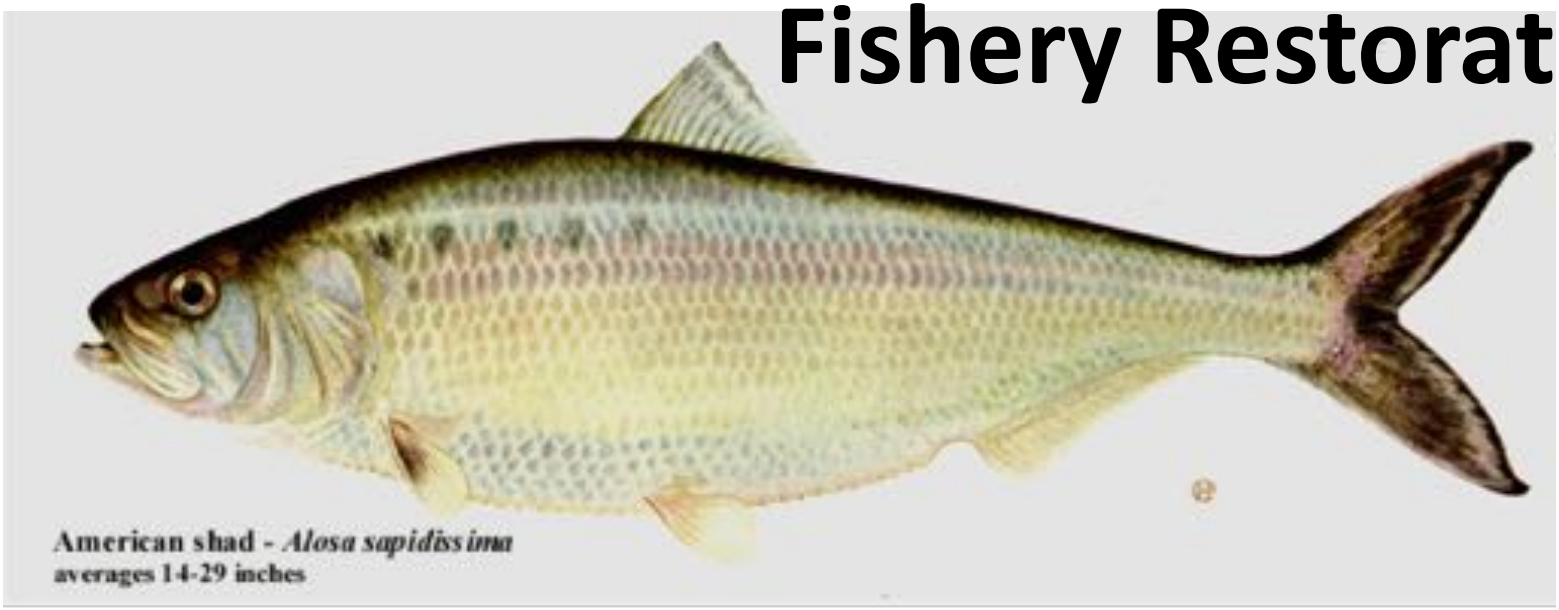
What is "UD WATER"?

The UD WATER Project (Watershed Action Team for Ecological Restoration) was formed in early 2008 as a collaborative initiative with the long-term goal of merging and facilitating university-wide efforts to minimize the environmental impacts of storm water runoff from our campus. The UD WATER initiative is synergistic with the University's Path to Prominence strategic goal to become a Green Campus.

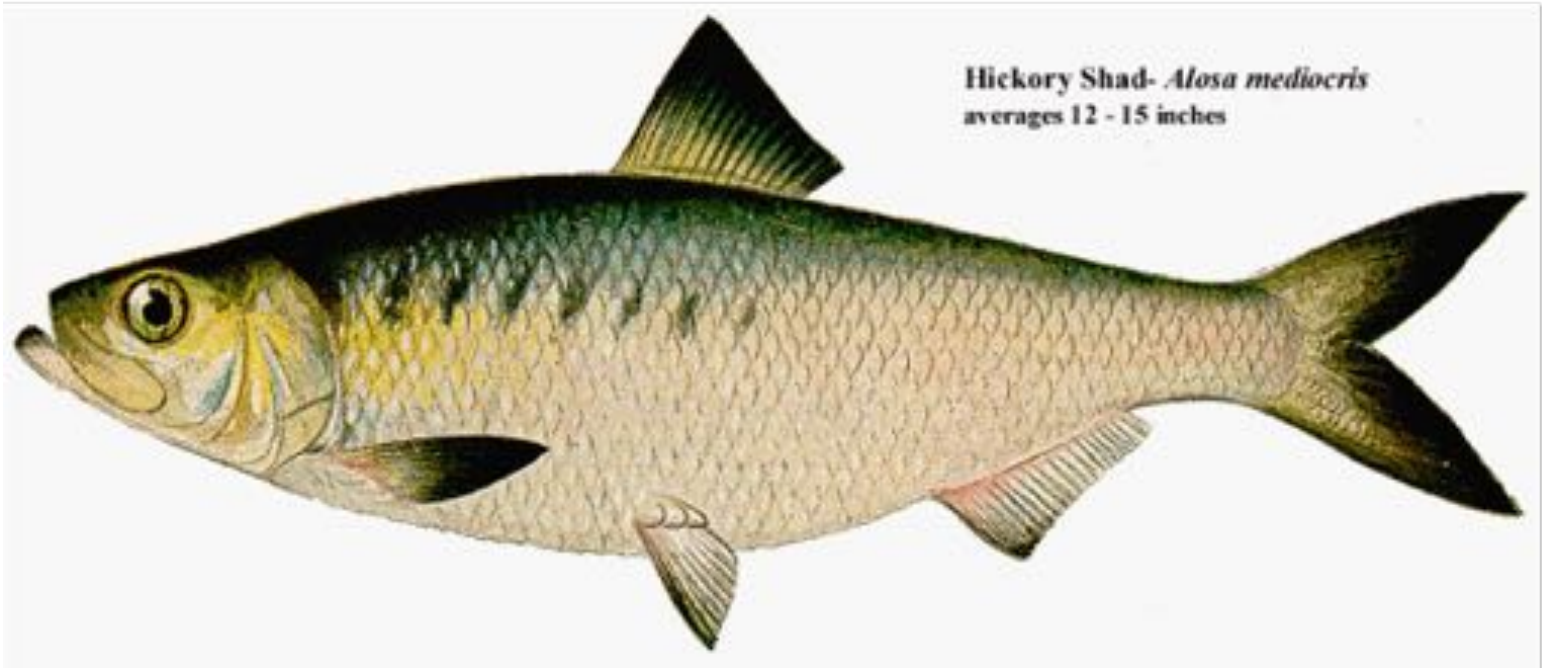
The UD WATER team brings together a consortium of faculty, staff, and students from various departments and disciplines across campus to work collaboratively to implement creative and innovative storm water management techniques in the most holistic and efficient manner achievable. The ultimate goal for this team is to reduce the quantity and increase the quality of storm runoff from campus properties, which will ultimately benefit our local waterways and is consistent with the mission of EPA regulations requiring the University and City of Newark to have a National Pollutant Discharge Elimination System (NPDES) permit. Membership on this team include faculty and staff from Occupational Health and Safety, Facilities Planning and Construction, Facilities Grounds Maintenance Services, Delaware Water Resources Center and the Departments of Bioresources Engineering and Plant & Soil Sciences within the College of Agriculture and Natural Resources, the Delaware Geological Survey, the UD Water Resources Agency within the Institute for Public Administration in the College of Education and Public Policy, and stormwater specialists from the City of Newark. UD WATER has also funded 6 undergraduate interns to work with UD faculty and staff and develop a watershed management plan for the UD campus.

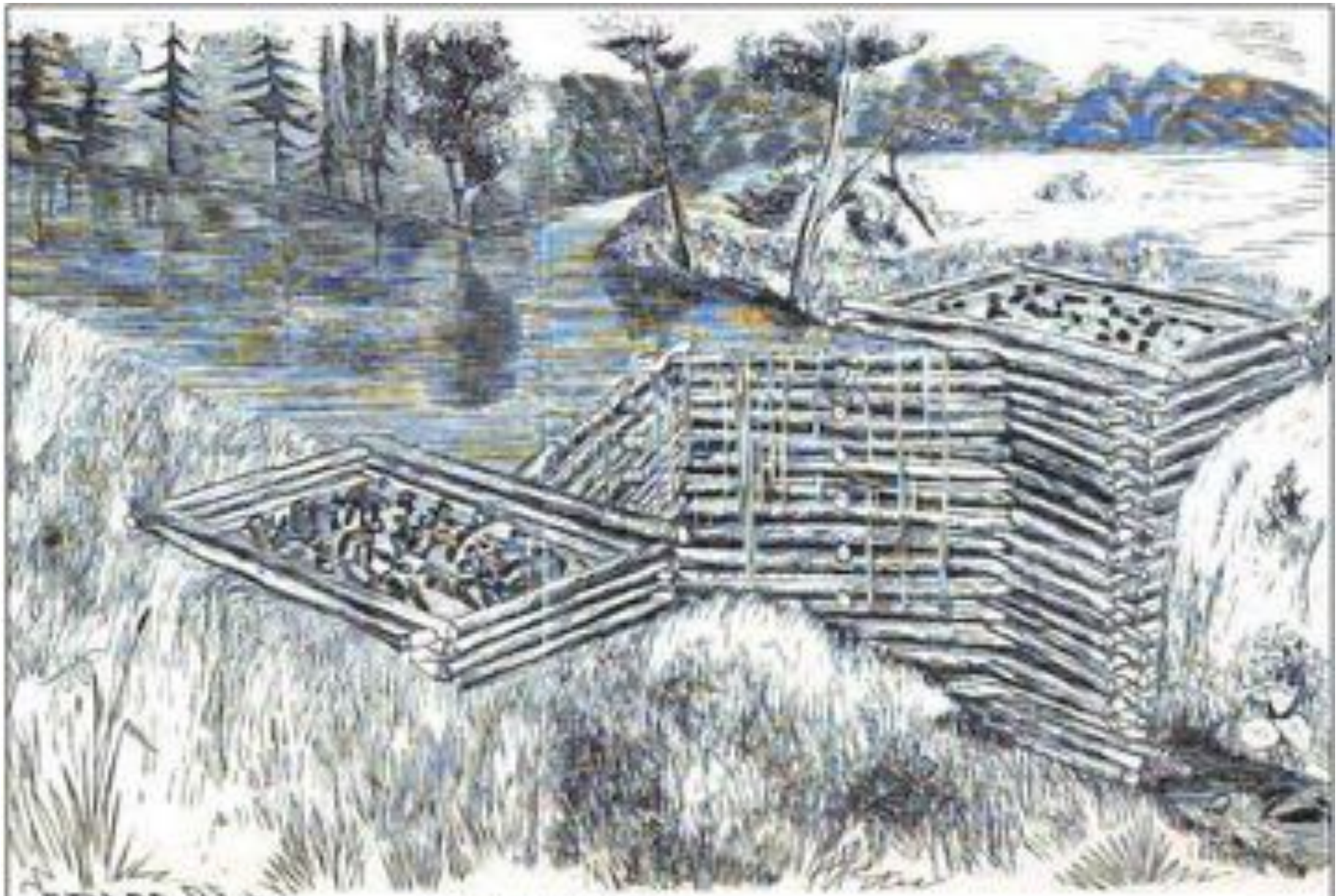
In the future, the UD WATER team hopes to add other faculty and students at UD with an interest in water resource management to participate in our efforts to use the UD campus as a storm water research laboratory for multiple disciplines. For more details, or to join the UD WATER project, contact one of the project co-directors, Dr. Tom Sims (Delaware Water Resources Center; jtsims@udel.edu) , Jerry Kauffman (UD Water Resources Agency, jerryk@udel.edu) or Leslie York-Hubbard (Occupational Health and Safety; lesliey@udel.edu).

Fishery Restoration



America's Founding Fish





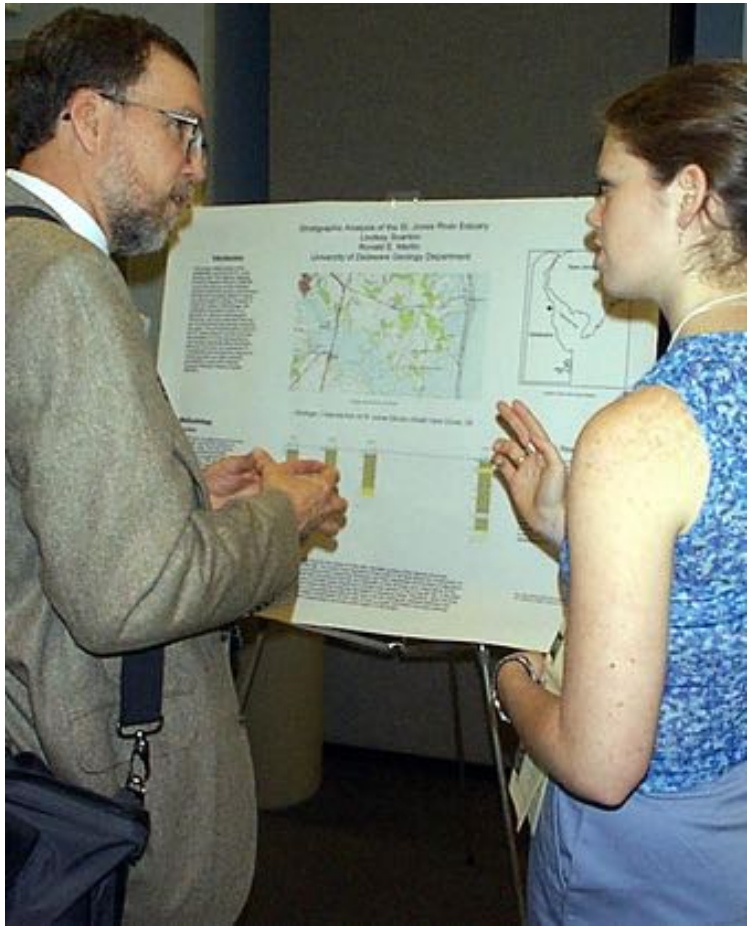
A CRIB DAM.


CAT


First State
National Monument

Thank you Dr. J. Thomas Sims!

Second Director of the Delaware Water Resources Center (2000-2015)



Deputy Dean

T. A. Baker Professor of Soil and Environmental Chemistry

College of Agriculture and Natural Resources

University of Delaware

UD Water Conservation Campaign 1980s AD