The Sandusky River Watershed Symposium:

An Overview

David Baker,
Interim Director
National Center for Water Quality Research
Heidelberg College

Water resource investigations and programs…

What's going on in the Sandusky River Watershed?

We asked that question in 1975.

The answers we got were published by the IJC.

Since that time….

- The Ohio Lake Erie phosphorus reduction program
- The Lake Erie Agricultural Systems for Environmental Quality project
- The CRP, CREP, and EQIP programs, the Lake Erie Buffer program
- The Sandusky River Watershed Coalition
- The Upper Sandusky TMDL program
- The St. John's Dam removal
- … many reports and publications
- … the Sandusky River Watershed Bibliography 200+ articles/reports
- See display of reports and papers reporting on the Sandusky

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Symposium Organization

Current Issues
↓
Water Resource Goals
↓
Tools to Reach Goals
↓
Funds for Implementation
↓
Changes on the Land
↓
Research and Monitoring

Watershed progress through the ongoing process of adaptive management

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Symposium Procedures

Times for questions and discussion:

- After individual presentations
- During refreshment breaks
- During lunches (now in Gillmor Atrium)
- Tuesday 4:10 – 4:30 PM session
- At the Barbeque Tuesday night

Laboratory tours

After lunches in Gillmor and before afternoon sessions

The NCWQR labs are on the third floor of Gillmor Hall

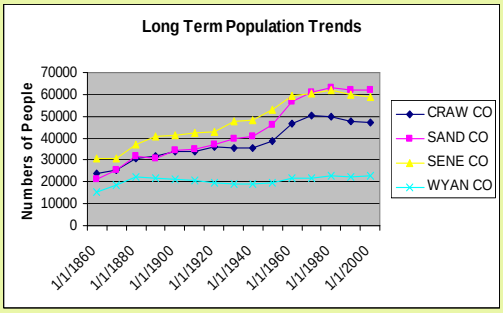
Sandusky River Watershed Coalition Symposium Committee

John Crumrine
Ken Krieger
Katie McKibben
Tia Rice
Chris Riddle
Stu Smith
Bob Vargo
Dave Baker, Chair

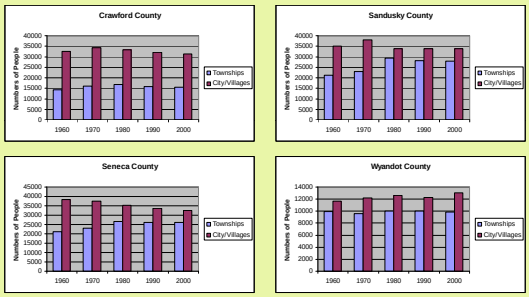
Land Use and Cover Changes within the Sandusky River Watershed – Implications for Erosion and Runoff Control Strategies

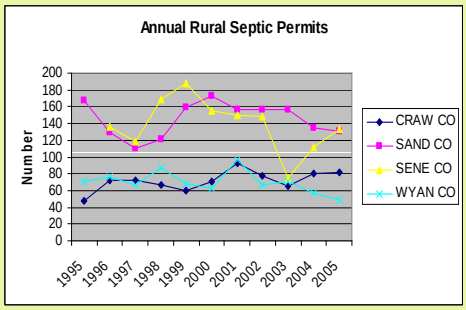
John P. Crumrine
Agricultural Project Coordinator
National Center for Water Quality Research
Heidelberg College

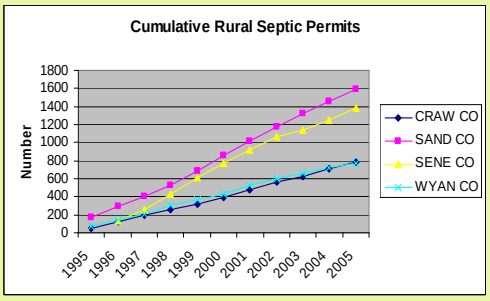
Sandusky River Watershed Symposium
June 27, 28, 2006

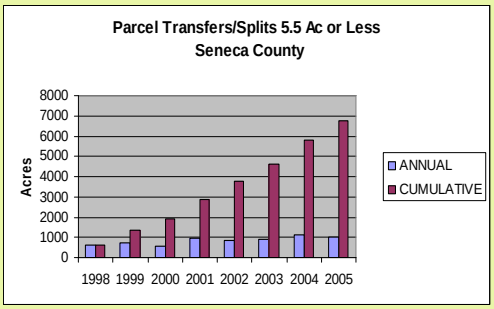


Rural-Urban Population Shifts



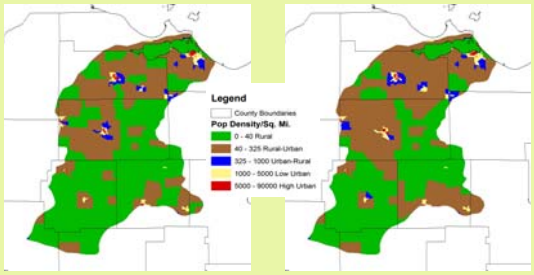




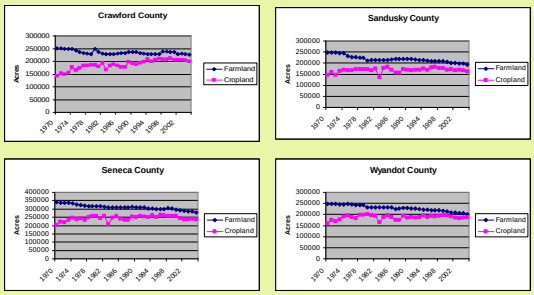


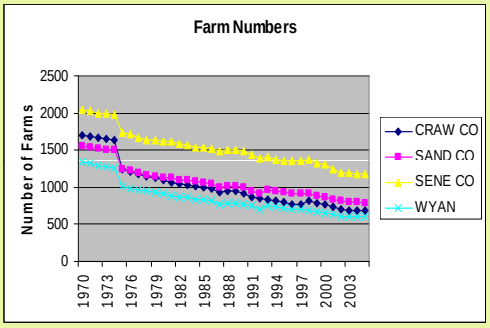
Population Shifts

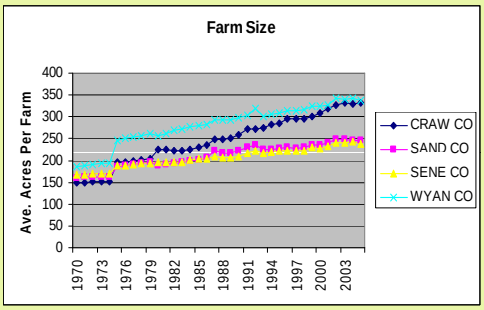
1970 2000



Farmland and Harvested Cropland Trends

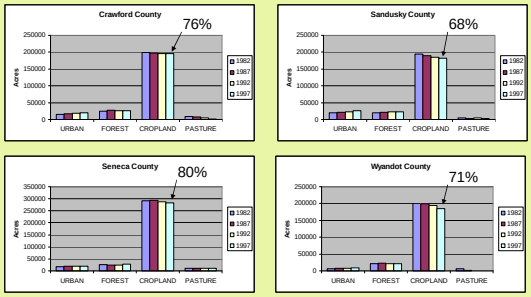


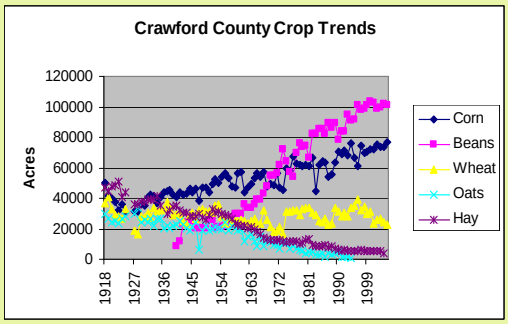


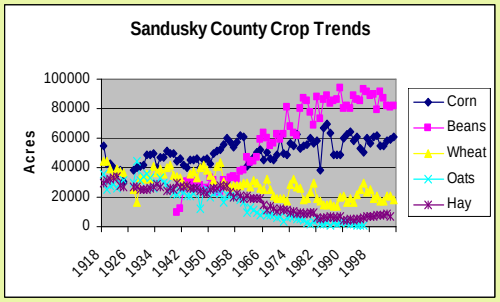


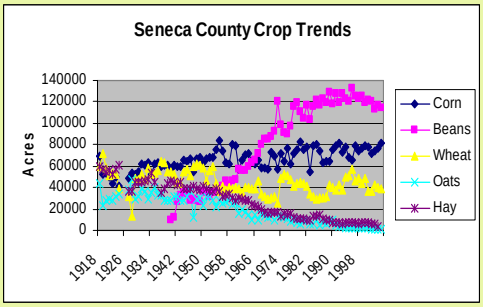
NRI Land Use

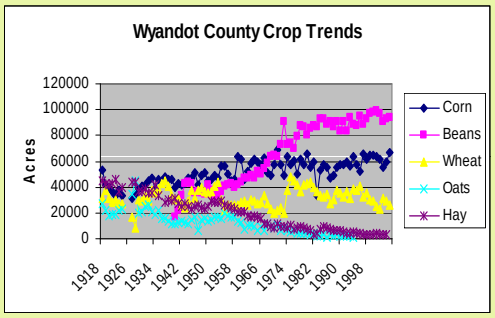
(1997 Cropland Percentages)






Sandusky County Crop Trends
Acres
100000
80000
60000
40000
20000
0
1918
1926
1934
1942
1950
1958
1966
1974
1982
1990
1998
Corn
Beans
Wheat
Oats
Hay


Seneca County Crop Trends
Acres
140000
120000
100000
80000
60000
40000
20000
0
1918
1926
1934
1942
1950
1958
1966
1974
1982
1990
1998
Corn
Beans
Wheat
Oats
Hay


Wyandot County Crop Trends
Acres
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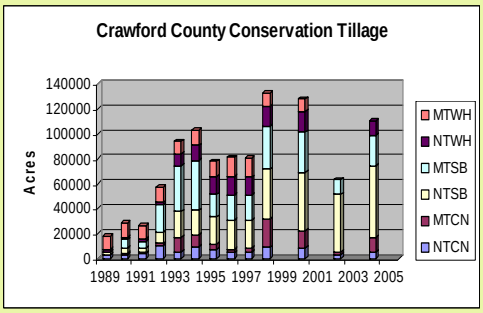
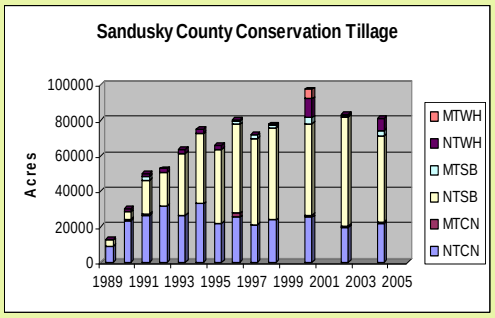
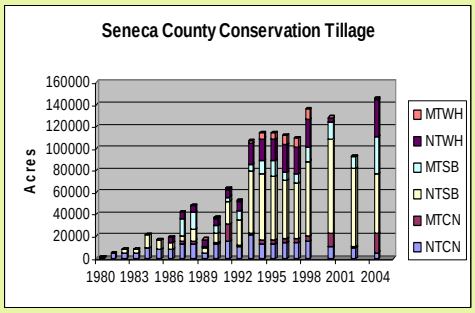
100000
80000
60000
40000
20000
0
1918
1926
1934
1942
1950
1958
1966
1974
1982
1990
1998
Corn
Beans
Wheat
Oats
Hay


Crawford County Conservation Tillage
Acres
140000
120000
100000
80000
60000
40000
20000
0
1989 1991 1993 1995 1997 1999 2001 2003 2005
MTWH
NTWH
MTSB
NTSB
MTCN
NTCN


Sandusky County Conservation Tillage
Acres
100000
80000
60000
40000
20000
0
1989 1991 1993 1995 1997 1999 2001 2003 2005
MTWH
NTWH
MTSB
NTSB
MTCN
NTCN


Seneca County Conservation Tillage
Acres
160000
140000
120000
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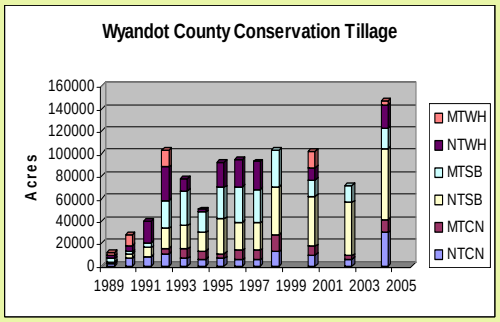
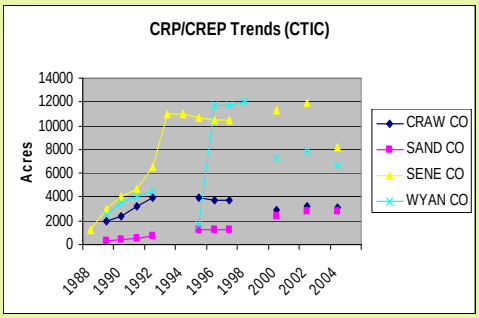
80000
60000
40000
20000
0
1980 1983 1986 1989 1992 1995 1998 2001 2004
MTWH
NTWH
MTSB
NTSB
MTCN
NTCN



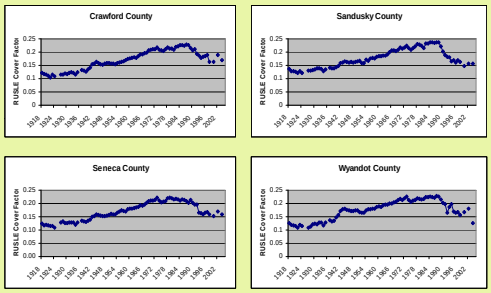


RUSLE COVER FACTOR CALCULATION ASSUMPTIONS

CROP/TILLAGE	RESIDUE AFTER PLANTING	RUSLE COVER FACTOR	COVER FACTOR EFFECT-IVENESS
CRP Sod - 10 year		0.002	140.00
Continuous Hay/Meadow		0.01	28.00
Continuous No Till WH/OATS	50%	0.02	14.00
Continuous No Till CN	40%	0.06	4.67
Continuous Fall Mulch Till WH/OATS	20%	0.07	4.00
Continuous WH/OATS Clean Till Spr/Fall	0%	0.12	2.33
Continuous No-till SB (drilled)	20%	0.13	2.15
Continuous Fall Mulch Till CN	20%	0.14	2.00
Continuous Fall Mulch Till SB	10%	0.21	1.33
Continuous CN Clean Till Fall	0%	0.23	1.22
Continuous SB (drilled) Clean Till Fall	0%	0.28	1.00

Long Term RUSLE Cover Factors

(1918 to 2004)



LAND USE AND FARM RUNOFF 1

Used the NRCS Engineering Field Handbook – Chapter 2
(Based on "old SCS" Runoff Curve Numbers where numbers are highest for impervious surface cover/soil conditions; and lowest for pervious surface cover/soil conditions).

Used the following input data or assumptions to make runoff estimates:

* 640 acre farm (or watershed)
* 7500 foot watershed hydraulic slope length
* 3 percent average watershed slope
* 10 percent maximum urban land use (model limit)
* Type II rainfall pattern
* Hydrologic Soils Group B
* "Good" soil condition (compare to "poor" condition)
* Evaluated output for 10 year storm – 3.6 inches in 24 hours

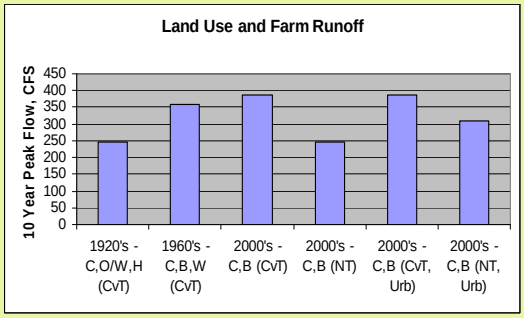
LAND USE AND FARM RUNOFF 2

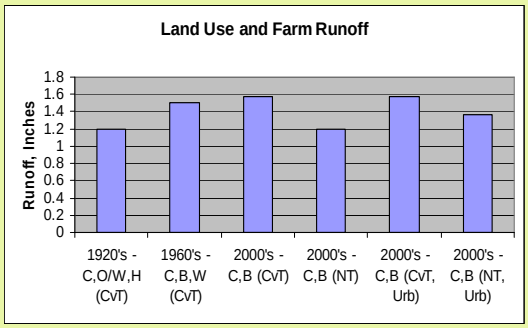
Used EFH-2 to evaluate the following scenarios:

1. 1920's – Corn, Oats/Wheat, Hay (Conventional tillage)
2. 1960's – Corn, Soybeans, Wheat (Conventional tillage)
3. 2000's – Corn, Soybeans (Conventional tillage)
4. 2000's – Corn, Soybeans (No-tillage)
5. 2000's – Corn, Soybeans (Conv till, 10% urban)
6. 2000's – Corn, Soybeans (No-till, 10% urban)

10% urban land use included:

7 acres – paved streets with curbs and storm sewers
7 acres – paved roads with open roadside ditches
10 acres – commercial and business
40 acres – residential 1 acre lots





Conclusions/Observations

- While trends in population, farmland and cropland are downward, urban areas, as measured by increases in rural population and residential development, are trending upward.
- Farm numbers are decreasing while farm sizes (and by observation, field sizes) are increasing.

Conclusions/Observations

- Cropland remains the dominant land use and varies from 68% in Sandusky County to 80% in Seneca County.
- Dominant agricultural cropland cover has changed from corn, small grains and hay in the 1920's to largely soybeans with corn and some wheat currently.

Conclusions/Observations

- The use of conservation tillage has grown since 1990, with no-till and mulch till soybeans plus no-till wheat being predominant practices.
- Whole field CRP acres grew in the early 1990's but have since remained level or decreased.

Conclusions/Observations

- Calculation of RUSLE cover factors since 1918 suggests that the adoption of conservation tillage in the 1990's has significantly reduced the potential for cropland erosion.
- Storm runoff calculations using the NRCS EFH-2 suggest that changes in either crop rotations, conservation tillage or extent of urbanization can all influence the rates of watershed runoff.

Municipal Point Sources: History and Direction

Elizabeth Wick, P.E.
Ohio EPA/NWDO
Division of Surface Water

Legal Authority

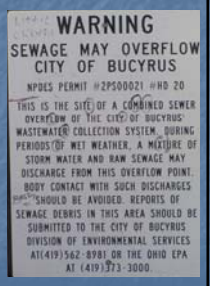
- Ohio Revised Code Chapter 6111
- Waters of the State
- National Pollutant Discharge Elimination System (NPDES) permit
  - Individual permit
  - General permit

Combined Sewer Overflows (CSOs)

- Combined sewers are built to carry sanitary waste in addition to storm water
- During rain events, volume of wastewater and storm water exceed sewer capacity
- Pipe overflows to nearest water body
- Ohio EPA CSO Control Strategy issued in 1995

Combined Sewer Overflows (CSOs)

- Primary goals of CSO policy:
  - No significant contribution to violations of water quality standards
  - No use designation impairments
  - Minimize total loading of pollutants discharged during rain events
- Implemented through NPDES permit conditions or enforcement actions



Combined Sewer Overflows (CSOs)

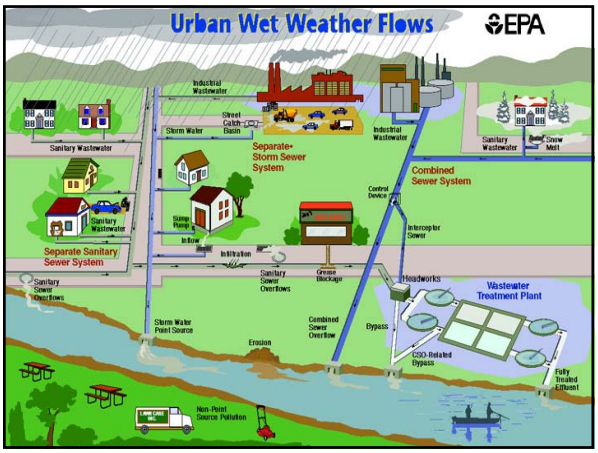
- Nine Minimum Controls
  - Simple technologies to minimize impact of CSOs
    - Proper operation and maintenance of collection system and overflow points
    - Maximize use of collection system for storage
    - Minimize the impact of nondomestic discharges
    - Maximize the capabilities of the POTW to treat wet weather flows

Combined Sewer Overflows (CSOs)

- Nine Minimum Controls
  - Prohibit dry weather overflows
  - Control solid and floatable materials in the CSO discharge
  - Conduct required inspections, monitoring and reporting
  - Implement pollution prevention programs
  - Implement public notification program for CSO areas

Combined Sewer Overflows (CSOs)

- Long Term Control Plan
  - Plan for elimination of impacts of CSOs
  - Methods to eliminate
  - Costs
  - Timeframes

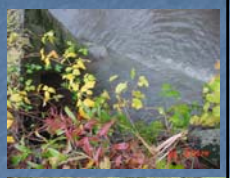


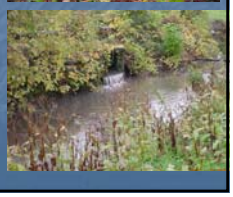
Major Municipal Point Sources

- City of Crestline
  - Original construction in 1948
  - Upgraded in 1994 – original plant used for storm water detention
  - Design flow 0.95 MGD, hydraulic capacity 2.2 MGD
  - Discharge to Westerly Creek
  - 10% combined sewers
  - 7 CSOs eliminated since 1998
  - 1 CSO remaining

Major Municipal Point Sources

- City of Crestline
  - NPDES permit expires July 2009
    - CSO monitoring and reporting
    - Includes schedule for elimination of last CSO by July 2009
    - Must operate in accordance with approved CSO Operational Plan
    - Must implement "Nine Minimum Controls"





Major Municipal Point Sources

- City of Bucyrus
  - Original construction 1939
  - Upgraded in 2003 as a result of a judicial enforcement action
  - Design flow 3.4 MGD
  - Discharge to Sandusky River
  - 80% combined sewers
  - 22 CSOs

Major Municipal Point Sources

- City of Bucyrus
  - NPDES permit expires October 2009
    - Requires CSO monitoring and reporting
    - Implement "Nine Minimum Controls"
    - Toxicity testing of effluent
- Currently working with USEPA on Long Term Control Plan for CSOs

Major Municipal Point Sources

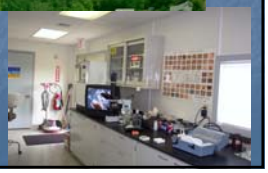
- City of Upper Sandusky
  - Originally constructed 1956
  - Upgraded in 1996
  - Design flow 2 MGD
  - Discharge to Sandusky River
  - 60% combined sewers
  - All CSOs eliminated but have a plant raw bypass

Major Municipal Point Sources

- City of Upper Sandusky
  - NPDES permit expires November 2009
    - High levels of Bis(2-ethylhexyl)phthalate (plasticizer) detected in plant influent
    - Requires identification of sources
    - Report due May 31, 2006
  - CSO monitoring and reporting
  - Elimination of raw bypass by May 1, 2007
  - Implement "Nine Minimum Controls"
  - Creating storm water storage at WWTP

Major Municipal Point Sources

- City of Tiffin
  - Originally constructed 1956
  - Upgraded in 1988
  - Design flow 4 MGD
  - Discharge to Sandusky River
  - 50% combined sewers
  - 30 CSOs
  - Wet weather flow bypassed to storm chlorine contact tank prior to combining with treated effluent



Major Municipal Point Sources

- City of Tiffin
  - NPDES permit expires in October 2009
    - Includes CSO monitoring and reporting
    - Development of Long Term Control Plan
    - Implementation of "Nine Minimum Controls"
    - Implementation of Pretreatment Program
  - In 2002, City approved a sewer separation plan over the next 20 years

Major Municipal Point Sources

- City of Fremont
  - Originally constructed in 1949
  - Upgraded in 1988
  - Design flow 7.6 MGD
  - Discharge to Sandusky River
  - 65% combined sewers
  - 13 CSOs

Major Municipal Point Sources

- City of Fremont
  - NPDES permit expires January 2007
    - Requires CSO monitoring and reporting
    - Submittal of Long Term Control Plan
      - Under review by Ohio EPA
    - Implementation of "Nine Minimum Controls"
    - Implementation of Pretreatment Program
  - Working on Master Plan including collection system, WWTP, floodwall
  - Research study to increase the organic capacity of the WWTP

Minor Municipal Point Sources

- Village of Carey (0.91 MGD)
- Village of Green Springs (0.24 MGD)
- Village of Attica (0.2 MGD)
- Village of Bettsville (0.175 MGD)

Minor Municipal Point Sources

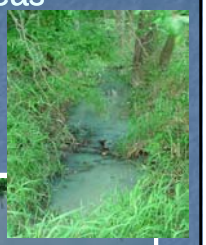
- Village of Sycamore (0.16 MGD)
- Village of New Washington (0.15 MGD)
- Village of Bloomville (0.1 MGD)
- Village of Nevada (0.09 MGD)
- Village of Republic (0.075 MGD)

Other Municipal Point Sources

- Ranchwood MHP (0.09 MGD)
- ODOT US 23 N and S (0.007 MGD each)
- Seneca Co Facilities (0.032 MGD)
- Foxfire Campground (0.009 MGD)
- Colonel Crawford HS (0.02 MGD)
- Walnut Grove Campground (0.006 MGD)
- Cranberry Hills Golf Course (0.002 MGD)

Unsewered Areas

- Areas Ohio EPA is currently working with:
  - Village of Bascom
  - Village of New Riegel
  - Village of Burgoon
  - Rt. 6 Area (CR 562, CR 243 and SR 6)
  - Huron and Harley Streets near Tiffin
  - Timpe Rd area near Fremont
  - Wightman's Grove
  - White's Landing

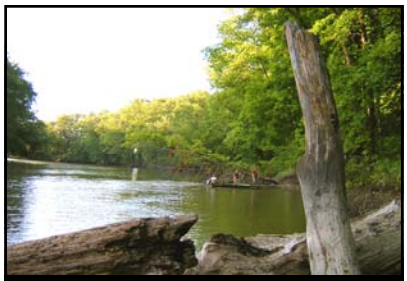


Next Steps

- Continue to eliminate impacts from CSOs
- Maintain compliance with all NPDES permits
- Identify impacts from unsewered areas
- Work with unsewered areas to abate unsanitary conditions
- Any input?

Biological and Water Quality Study of the Sandusky River 2001

What do you want your stream to look like?



Reference sites

- Ecoregion specific
- Preference for least impacted conditions
- Statewide about 500 sites
- Biological performance at these locations is the basis for biocriteria

Modified Reference Sites

- Channel modified
  - (HELP specific / other ecoregions combined)
- Impounded (No ICI)
- Mine affected (WAP specific)

Tiered Aquatic Life Uses

- Warmwater Habitat (WWH)
- Exceptional Warmwater Habitat (EWH)
- Modified Warmwater Habitat (MWH)
- Limited Resource Water (LRW)
- Coldwater Habitat (CWH)
- Seasonal Salmonid

Biocriteria for Eastern Corn Belt Plains

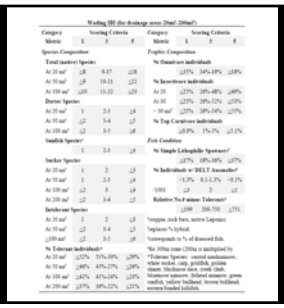
IBI			MIwb		ICI	Narrative Evaluation
Headwater	Wading	Boat	Wading	Boat	All	
50-60	50-60	48-60	9.4	9.6	46-60	Exceptional
46-49	46-49	44-47	8.9-9.3	9.1-9.5	42-44	Very Good
40-45	**40**-45	**42**-43	**8.3**-8.8	**8.5**-9.0	**36**-40	Good
36-39	36-39	38-41	7.8-8.2	8.0-8.4	32-34	MarginallyGood
28-35	28-35	26-37	5.9-7.7	6.4-7.9	14-30	Fair
18-27	18-27	16-25	4.5-5.8	5.0-6.3	2-12	Poor
12-17	12-17	12-15	0-4.4	0-4.9	<2	Very Poor

Modified Biocriteria

IBI			MIwb		ICI	Type
Headwater	Wading	Boat	Wading	Boat	All	
18 (Poor)	18 (Poor)	18 (Poor)	4.5 (Poor)	5.0 (Poor)	8 (Poor)	Limited Resource Water
All ecoregions except HELP						
24 (Poor)	24 (Poor)	24 (Poor)	6.2 (Fair)	5.8 (Poor)	22 (Fair)	Channel Modified
-	-	30 (Fair)	-	6.6 (Fair)	-	Impounded

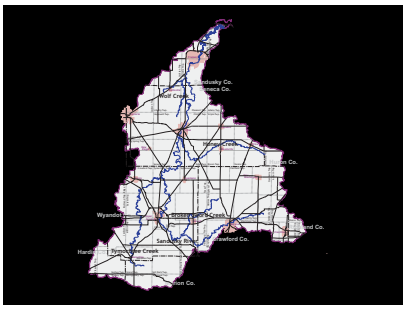
Index of Biotic Integrity

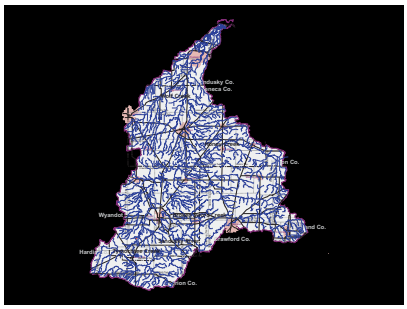
- 12 metrics (scoring categories)
- Each metric is scored: 1, 3, or 5
- 12 is lowest score, 60 is highest score

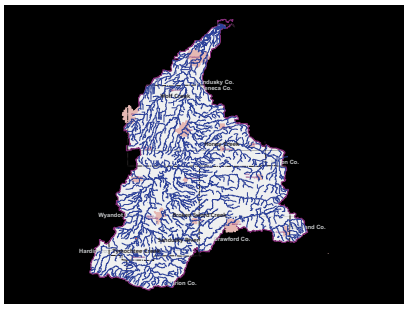


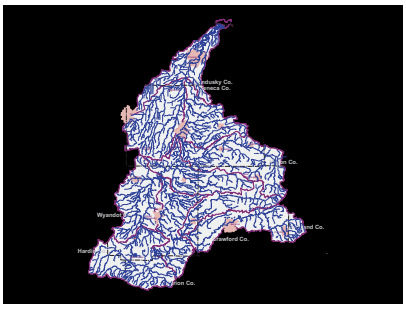
Email from Dr. Baker:

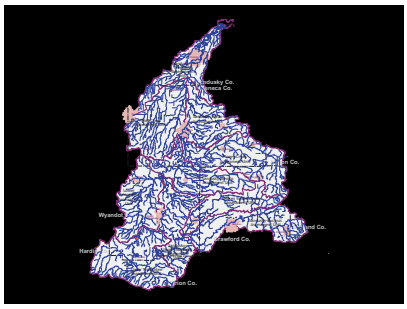
Since improving the biological status of the Sandusky watershed streams will be the focus of so much of the restoration efforts in this watershed, it is essential that conference attendees have a clear picture of the current status of these communities and your assessments of the causes and sources of impairments.

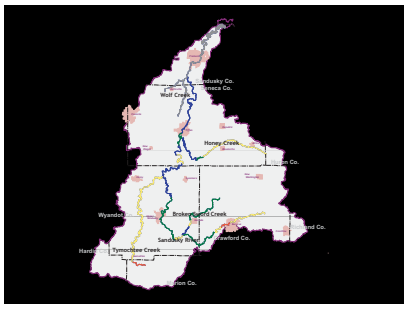


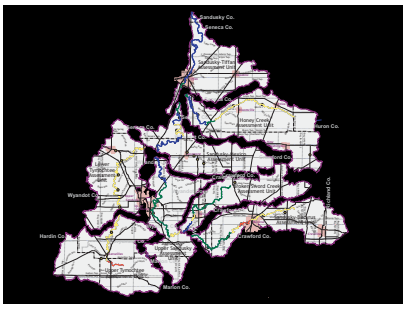


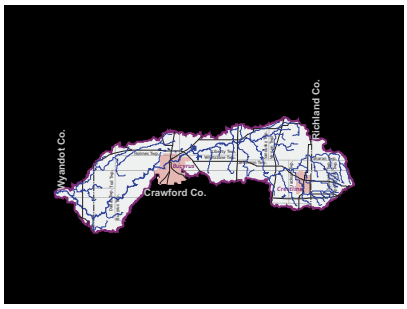


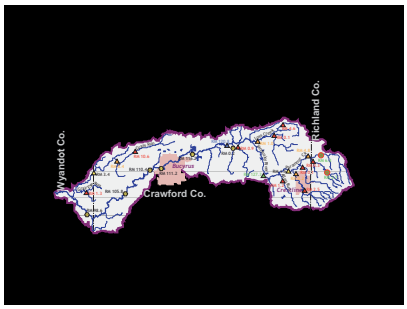








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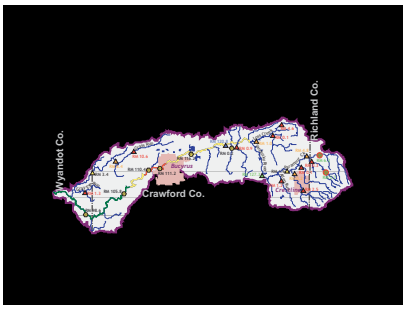
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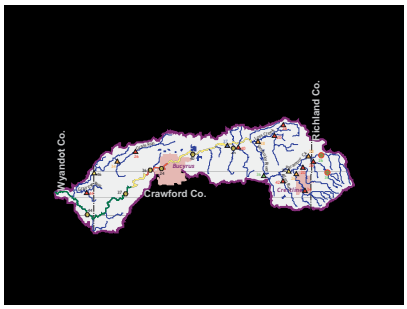
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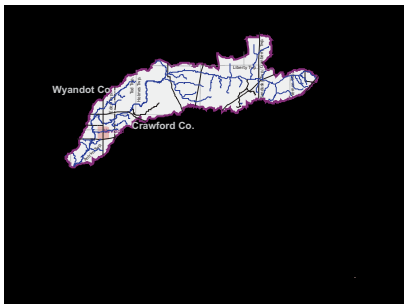
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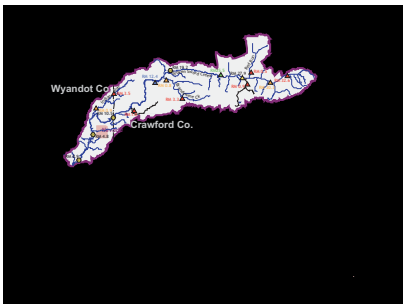
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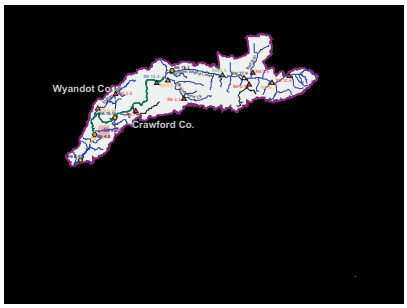
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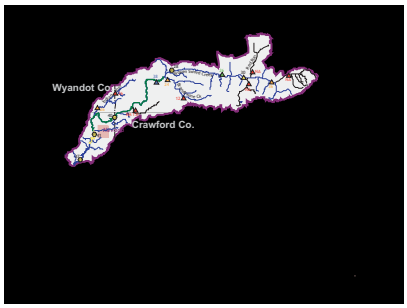
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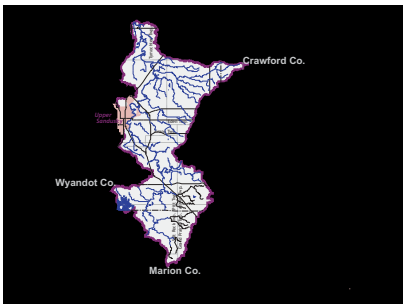
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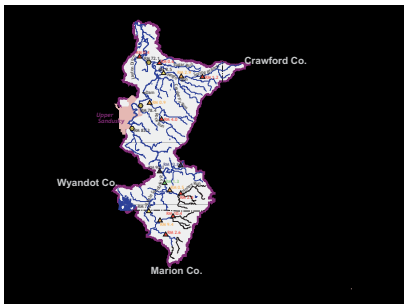
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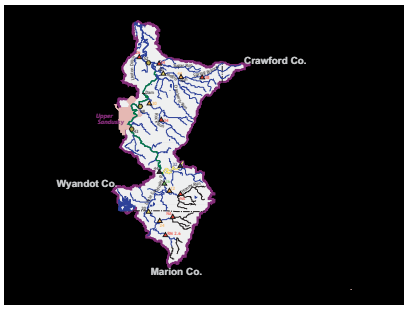
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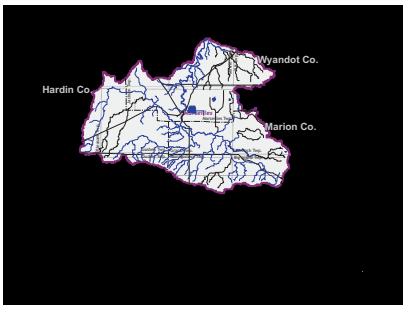
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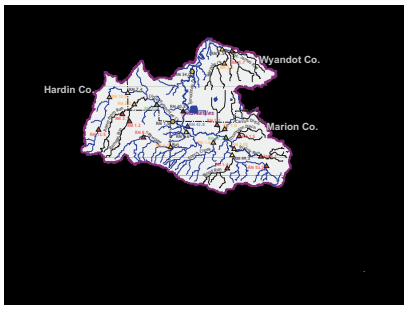
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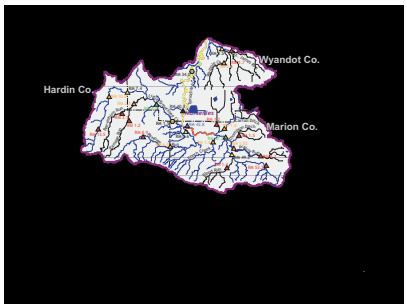
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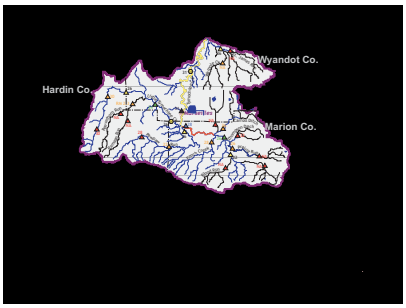
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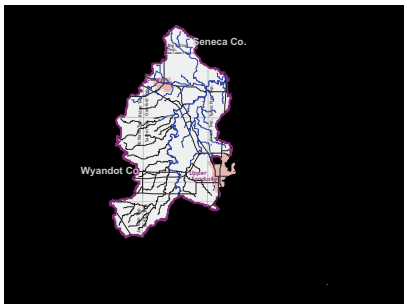
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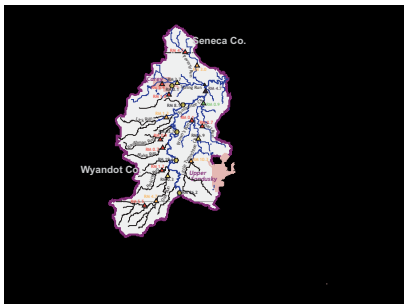
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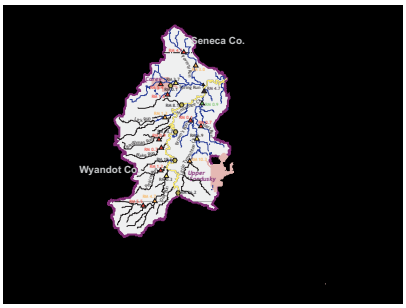
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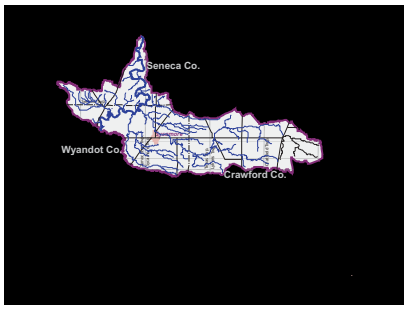
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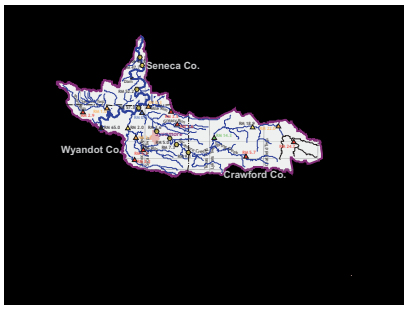
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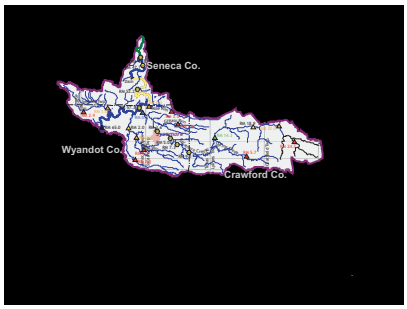
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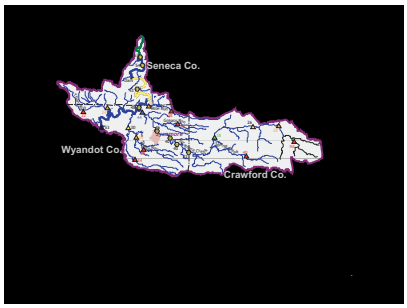
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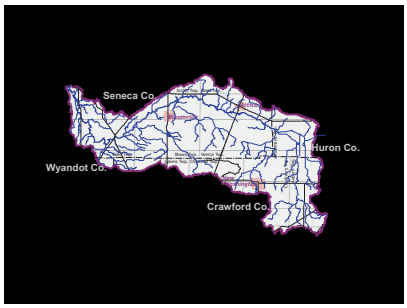
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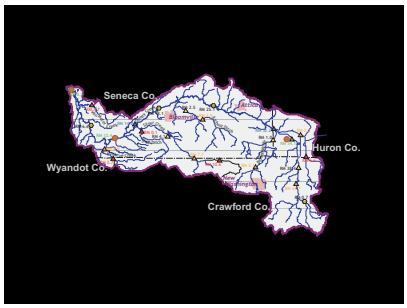
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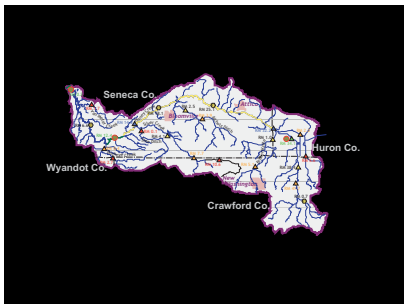
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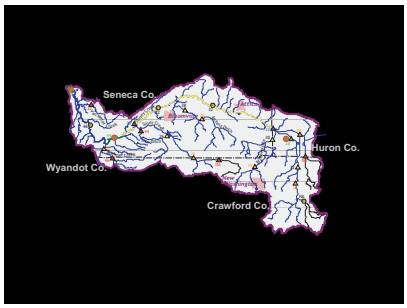
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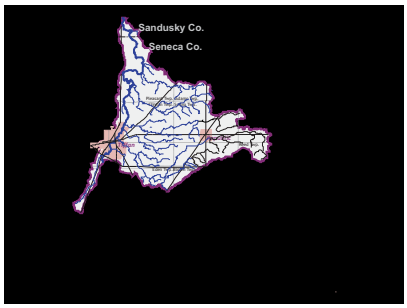
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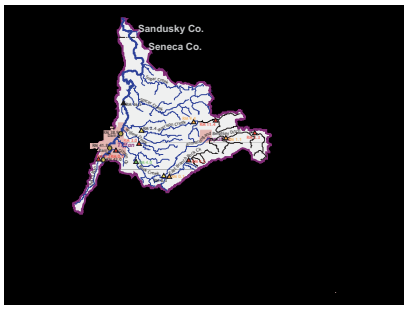
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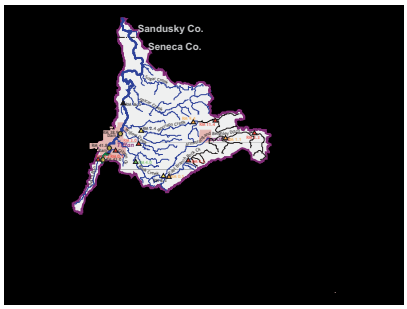
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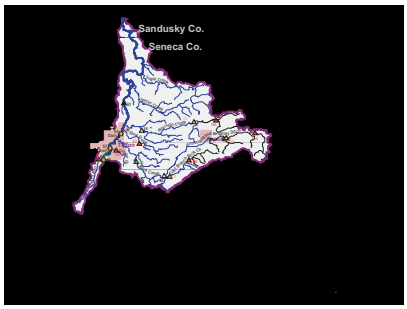
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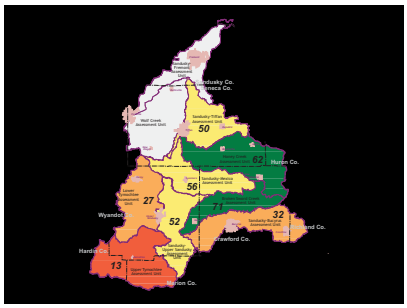
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Drainage Issues in the Sandusky River Watershed

Sandusky River Watershed Symposium
June 26, 2006

"Drainage" – According to Webster

- The process of draining liquid from something
- To Drain – "to flow out of something, often leaving it empty or dry"

Who needs drainage?

Agricultural Drainage

- Soil Conservation & Enhanced Crop Production
- 55% Ohio's soil need drainage
- 1850's was the beginning of draining land in Northwestern Ohio
- Two types of drainage improvements – Surface & Subsurface
- OSU FactSheet "Understanding Agricultural Drainage"; Brown & Ward

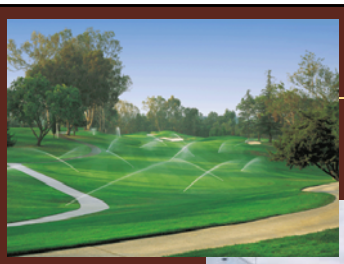
Grass Waterways – Columbus, OH

Thomas Jefferson

- **Cultivators of the earth are the most valuable citizens. They are the most vigorous, the most independent, the most virtuous, and they are tied to their country and wedded to it's liberty and interests by the most lasting bands**

Issue – "Subject of Concern"

- Some people want water, some people don't
- Competition for it's use
- Demand for it's disposal



All Best Management Practices (BMP's) need Drainage

- Waterways
- Conservation Tillage
- Reverted wetlands
- Ponds
- Manure Management

Everyone Needs Drainage…

- Road beds
- Recreation
- Waste handling
- Houses, Buildings, Structures
- Public Health
- Not a positive or negative conotation

Changes\Improvements in Technology

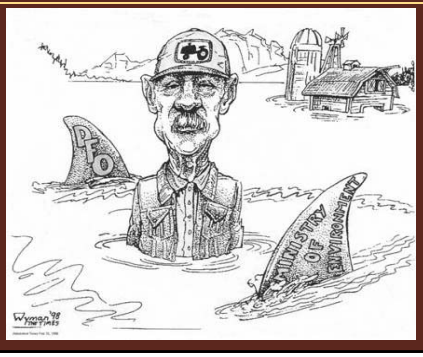
- 50 men – 12 hour day – 300 feet
- 1890's Steam powered ditch machine invented in Bowling Green, Ohio – 3 feet per minute
- Current machines –
- Water quality measurements/tools
- Irrigation Systems
- Computer and data storage/usage

Marsh Run, Franklin County

Original Drainage Improvements need to be maintained

- Permanent Maintenance legally established in 1957
- Many systems designed only for agricultural use now being used for urban
- Over 3000 miles of maintained channels in 1996 (Atherton, 1999)
- Annual average request 150 new projects (Atherton, 1999)

Which is more important Water Quality or Drainage?



Depends…

- SWCD's previously balanced both
- SWCD's continue to try to balance both
- SWCD's want to balance both in the future

- ODNR Drainage Advisory Committee –
  - Develop standards focused on environmental stewardship
  - Deteriorating rural drainage system, backlog of projects, rural & urban functions, administration, programs and jurisdictional powers – Consider legislative changes

Legal rights & responsibilities

- Jurisdiction
- Regulation
- Recourse
- Improvement processes
- Establishing drainage benefits

Lucas County, 1924

Complexity of projects

- Increased costs
- Unrealized benefits
- Multiple landuse & drainage needs
- Better understanding of drainage cause & effects
- More landowners involved and uneducated

Drainage knowledge – or lack of

- 1st hand experience/interest/involvement gone
- Neighbors
- Politicians
- Business Owners
- Local Authorities
- Landowners

Differences in degrees of drainage

- Faster, Slower – Flashiness of streams
- Larger, smaller
- Visible, "invisible"
- Established, undeveloped

Need for continued improvements

- Changes in farming practices
- Increased costs with lower returns
- Additional landuses – drainage needs
- Increased infrastructure
- Greater investments – need for protection

Water Always Wins

- Water is a problem or a benefit depending where it is
- Don't you realize that the sea is the home of water? All water is off on a journey unless it's in the sea, and it's homesick and bound to make its way home someday. (Zora Neale Hurston)

Ohio River, 1997 (Visuals Unlimited)

Soil & Water Conservation District's Role

- Cooperation and conflict resolution for the maintenance and improvement of effective drainage while conserving our natural resources
- Agencies, local officials, landowners, homeowners, politicians, researchers

Conclusion

- Drainage is not a bad word
- Everyone needs drainage, farmers need it for their job
- Water Quality and Efficient Drainage can coexist – we may need to work harder together!
- There will always be issues with drainage
- Speculations, site visits, personal insight should not become scientific proof to support or blame drainage.

It all began with free-range chicken.
Then it was organic vegetables.
Next the farmers decided they should
all take a year off to go find themselves.

Household Sewage Treatment Systems – Issues & Programs

Kate Siefert, R.S.
ksiefert@odh.ohio.gov

Crawford County General Health District
Bucyrus, OH

Every day, it is estimated that the people on Earth produce **11 billion pounds** of sewage. (Every day!)

The average Ohio household produces 360 gallons of wastewater per day (…2,520 gal/week & 131,040 gal/year).

What is a Household Sewage Treatment System (HSTS)?

A two-seater outhouse – one side with carpet? (not exactly)

And every Health inspector's favorite quote from a homeowner - *"But my house is Grandfathered!?!"*

- A common misconception, homeowners often feel that since they live in an older home, their sewage somehow doesn't pollute – regardless of whether or not they have a septic system.

Types of HSTS:

- **Discharging systems** – aeration tanks, subsurface sand filter beds, upflow filters
- **On lot systems** – leach fields, mound systems, peat bio-filter systems, drip distribution systems

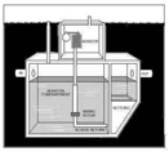


Figure 1–An example of a possible aerobic unit design

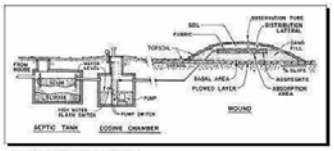


Figure 3: Schematic of a Wisconsin Mound System

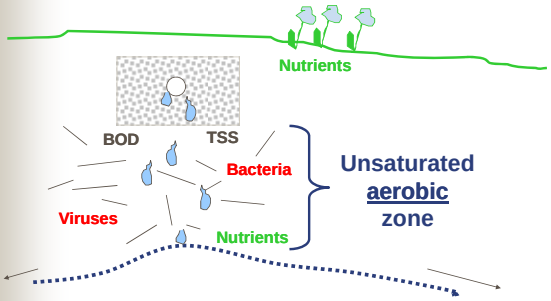
Discharging Systems – Key Issues

- Ohio has been in violation of National EPA standards for discharges from home septic systems for many years
- Homeowners often neglect the necessary maintenance needed to properly treat the discharging wastewater
- Often associated with small lots in concentrated areas (small villages)

Key Issues for On Lot Systems – Unsuitable sites & soils

- Long history of leaching trenches in saturated soils – dilution versus treatment

Treatment in Soil



Limiting condition of perched seasonal high water table

And now, new to 2006…the biggest change in Ohio's sewage history….

…the passing of HB 231

Adoption of New Sewage Treatment System Rules (HB 231) – May 4, 2006

OAC, Chapter 3701-29

- Prior to HB 231, the household sewage treatment program was the only ODH environmental health program without a specific **governing statute**.
- The ODH household sewage system rules have not been updated since 1977 … and **over a quarter century** much has changed.

What does this mean for future installations of septic systems?

- Very detailed site evaluations requiring a minimum of 2 feet of suitable soil prior to a limiting condition (seasonal ground water, bedrock, etc.)
  - This means most systems will have pre-treatment or have to be a mound type system.
- Homeowners will most likely need an evaluation from a soil scientist prior to Health Dept. approval.

- All installations will have to be re-inspected within 18 months of installation by the health dept.
- All septic systems will be required to have an Operation & Maintenance Permit.
- Rules will significantly limit the use of discharging systems (no discharging systems for newly constructed lots)
- Replacement systems that discharge off lot are required to obtain an NPDES permit through OEPA
- Yearly testing required for all discharging systems

Household Septic System Replacement Program in the Sandusky River Watershed

Cost Share funding by the Ohio EPA working in conjunction with your local health department.

OhioEPA

Overview of the 319 Grant

The goal is a replacement of at least 170 household sewage treatment systems in 9 target areas of Crawford, Erie, Sandusky, Seneca & Wyandot counties with a total of $740,000 federal monies.

Reduction of over 29 million gallons of untreated sewage discharged into surface and ground waters of the Sandusky River Watershed annually.

Water samples taken by OEPA from tributaries of the Upper Sandusky River in Crawford County

– prior to replacing any septic systems

Criteria for Participants

- Homes with failing systems in the target areas. Or…
- Homes with no record of a household sewage treatment system in the target areas. Or…
- Homes with an older discharging system that choose to upgrade to an on-lot system.

Cost Share Available

- **50%!**
- **Up to $4,000 for septic tank and conventional leaching field systems**
- **Up to $6,000 for alternative/experimental systems**
- **Additional Assistance (up to 75%) for Low-Income Applicants**
- **Low Interest Loans available at United Bank (Crawford County) & Republic Banking Company (Seneca County).**

Conventional System

(2 compartment tank, distribution box, leaching tile field)

Cost Share Available up to $4,000

Experimental/Alternative Systems

Finished & Landscaped Peat Biofilter System

Cost Share up to $6,000

Aeration Tank & Leach field

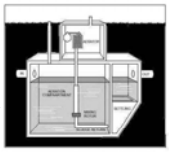


Figure 1–An example of a possible aerobic unit design

Drawing Schematics of a Mound System

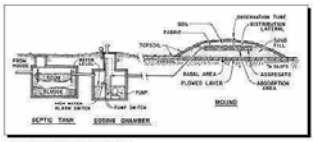


Figure 1: Schematic of a Wisconsin Mound System

OEPA S.319 Success Stories!

To date, **72** approved applications for replacing their septic systems!

This home used to discharge directly to a tributary of the Sandusky River – toilet paper and all!

Thank you!

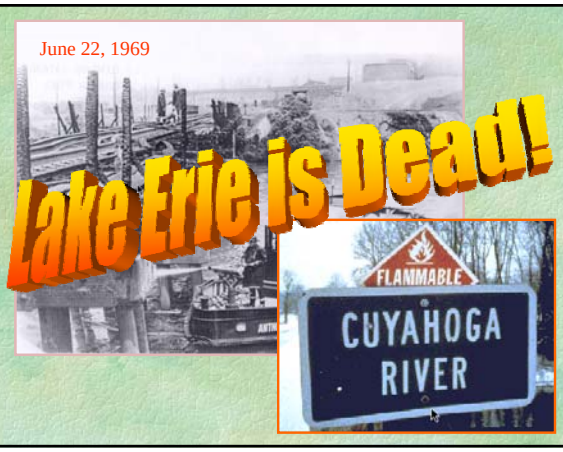
Questions?

Pollutant Loading to Lake Erie: History and Status

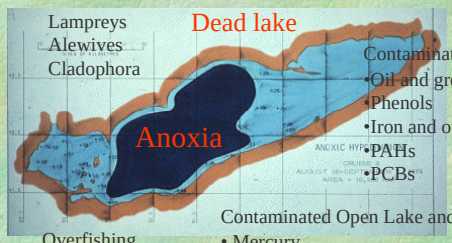
R. Peter Richards
National Center for Water Quality Research
Heidelberg College
Tiffin, Ohio 44883

Road Map...

- Background - why loading is an issue
- Total lake loads and Lake Erie target load
- Loads from the Sandusky, in context of other tribs
- Trends in loads and concentrations
- A side note on Sandusky as drinking water supply



What was wrong with Lake Erie?



Lampreys
Alewives
Cladophora

Contaminated Harbors
•Oil and grease
•Phenols
•Iron and other metals
•PAHs
•PCBs

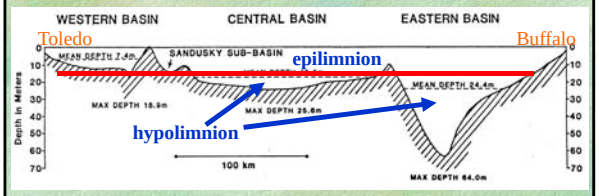
Overfishing
•Blue Pike
•Walleye

Contaminated Open Lake and Fish
• Mercury
• PCBs
• DDT, DDE

No more mayflies...

Causes of anoxia

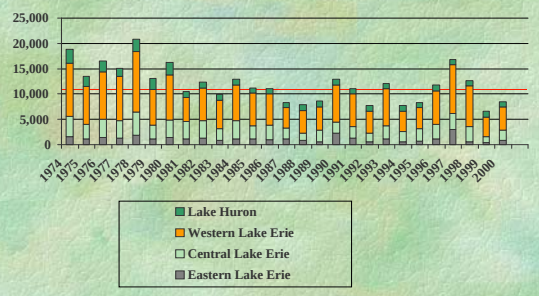
- A Central Basin problem
- Excess nutrient loading
- Thin hypolimnion



Strategy for reducing anoxia

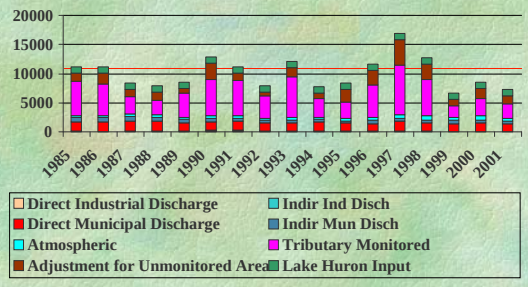
- Make phosphorus the limiting nutrient
- Reduce phosphorus inputs
  - Detergent phosphorus ban
  - Sewage Treatment Plant upgrades
  - Nonpoint source management
    - Fertilizer and manure management
    - Conservation tillage
- Target Load of 11,000 metric tons/yr from all sources

Total Lake Loads, 1974 to 2000



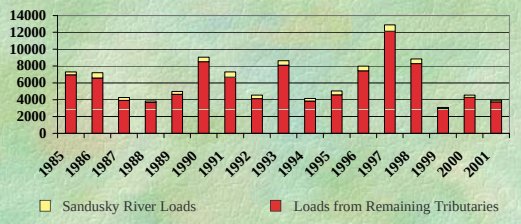
Dave Dolan, UWGB

Total Lake Loads, 1985 to 2001



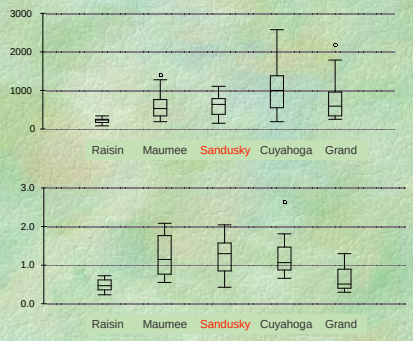
Dave Dolan, UWGB

Sandusky and All-tributary Loads

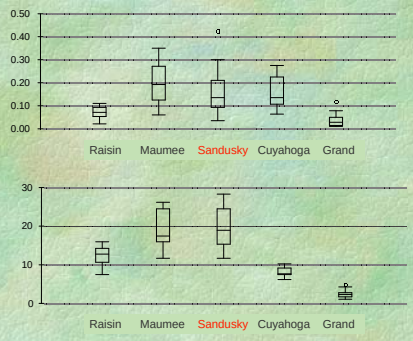


Sandusky load is ~4% to 9% of load from all tributaries

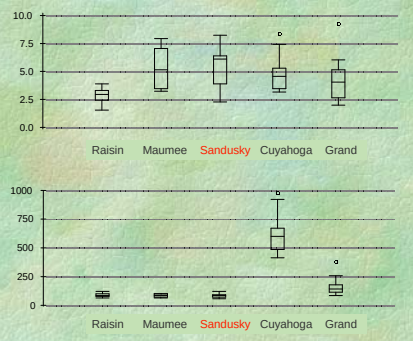
Unit Area Loads (kg/ha/year, 1990-2004)



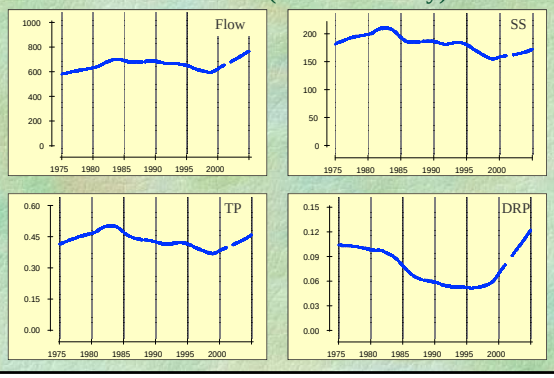
Unit Area Loads (kg/ha/year, 1990-2004)



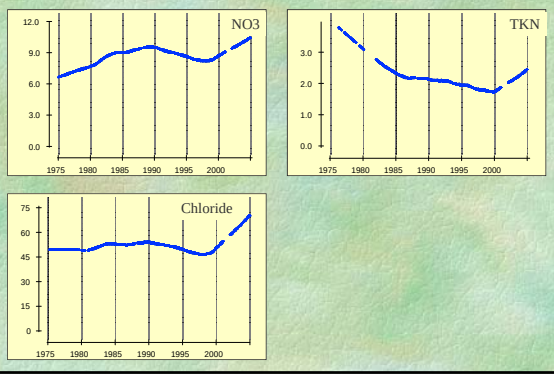
Unit Area Loads (kg/ha/year, 1990-2004)



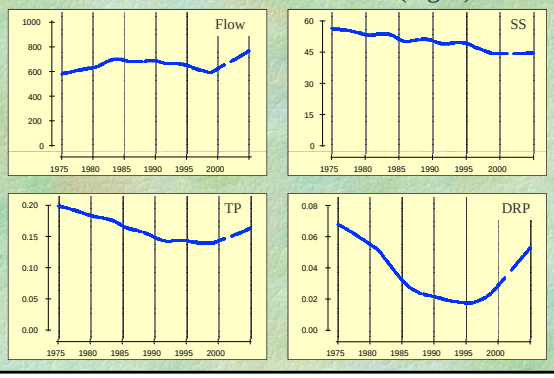
Trends in Loads (metric tons/day)



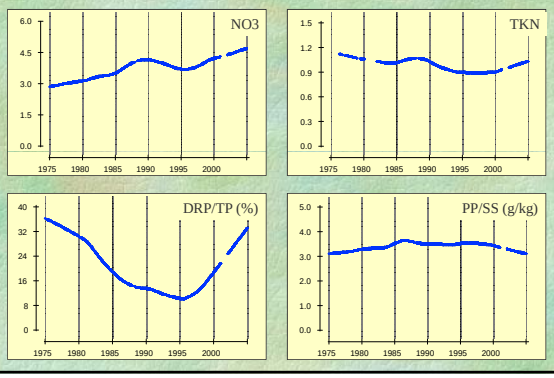
Trends in Loads



Trends in Concentrations (mg/L)



Trends in Concentrations



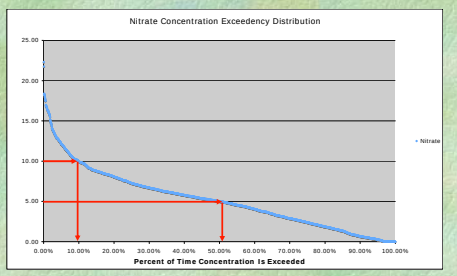
Impacts?

- Renewed problems in Lake Erie
  - Increased in-lake phosphorus concentrations
  - Hypoxia in summer
  - Microcystis and other cyanobacteria
- Tributary inputs are probably contributing to these problems

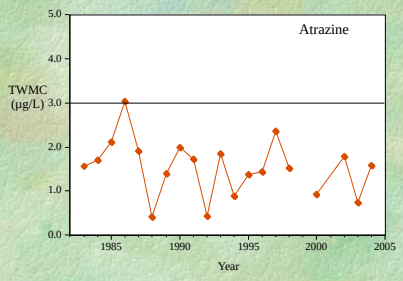
Sidebar - The Sandusky as a Drinking Water Source

- Nitrates compared to MCL of 10 mg/L
- Pesticides compared to compound-specific drinking water criteria

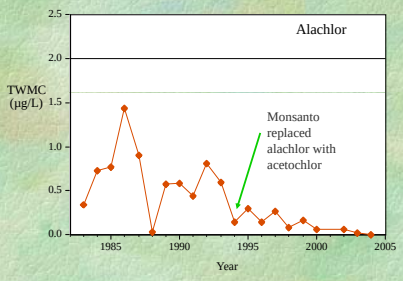
The Sandusky as a Drinking Water Source - Nitrate



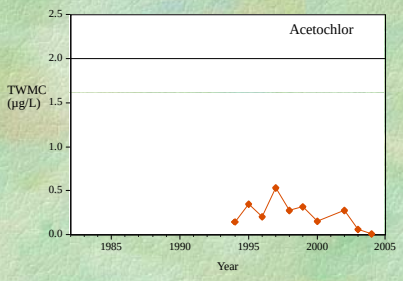
The Sandusky as a Drinking Water Source - Atrazine



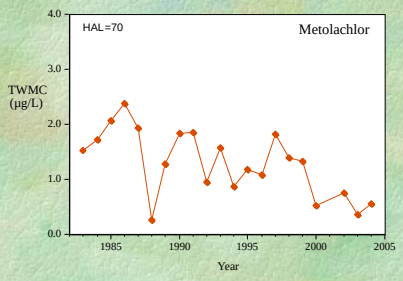
The Sandusky as a Drinking Water Source - Alachlor



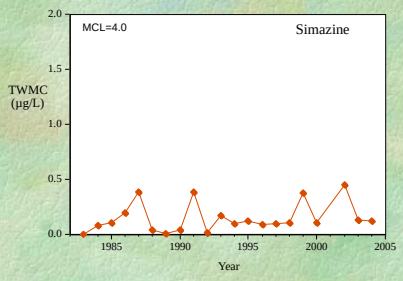
The Sandusky as a Drinking Water Source - Acetochlor



The Sandusky as a Drinking Water Source - Metolachlor



The Sandusky as a Drinking Water Source - Simazine



Some Conclusions

- Sandusky River loads of total phosphorus are less than 10% of total tributary loads to Lake Erie; decreased from 1975-1995, but increased since 2000 along with increased flow.
- Sediment loads have decreased. Dissolved reactive phosphorus loads decreased but have increased since 1995. Nitrate and chloride have increased.
- On a unit area basis, Sandusky (along with Maumee) has relatively high loads compared to other U.S. tribs to Lake Erie (except chloride)
- Nitrate exceeds drinking water standard ~10% of the time; pesticides generally below their human health limits.

Drinking Water Issues in the Sandusky River Watershed

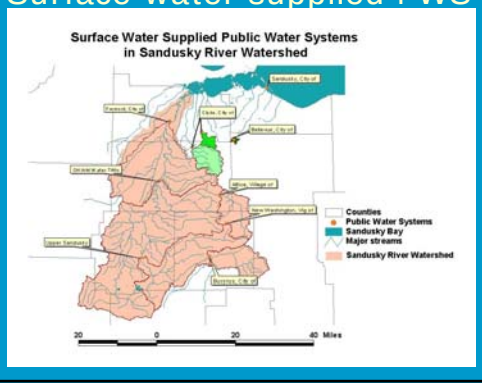
Stuart A. Smith, MS, CGWP

The Sandusky has long been important as a water resource to human settlement

The watershed is a major drinking water source for humans

Somewhere in Upper Sandusky

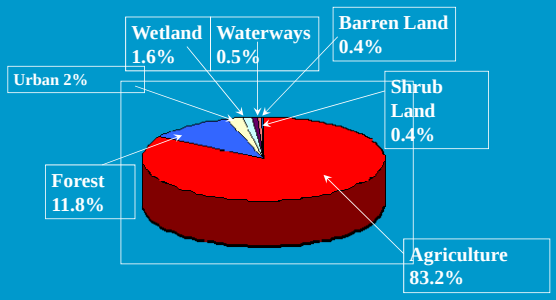
Surface water supplied PWS



Water Quality Impacts

- Land use: What runs into the drainage or infiltrates into ground water?
- Seasonality of quality: nitrates, pesticides, etc.
- Flow variability: flushing effect on wastewater outfall
- Availability of protected water sources

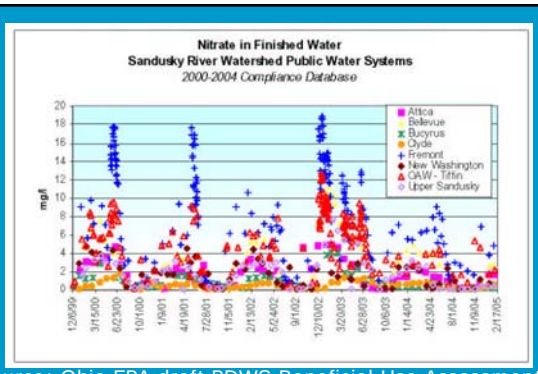
Land Use Patterns In The Sandusky Watershed



There is too much direct flow of domestic wastewater into tribs

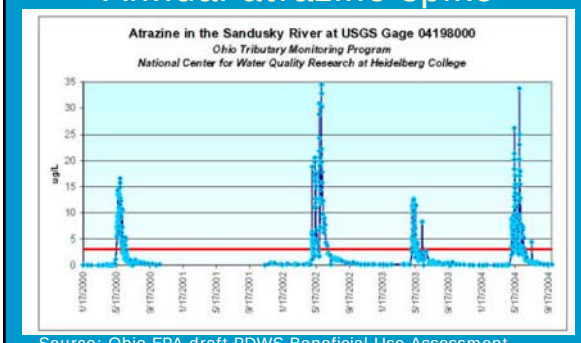
Upstream – Large-scale animal operations

- Unknown – depending on validity of manure management plans
- Shallow bedrock, weathered soils
- Nearby shallow ground water supplies

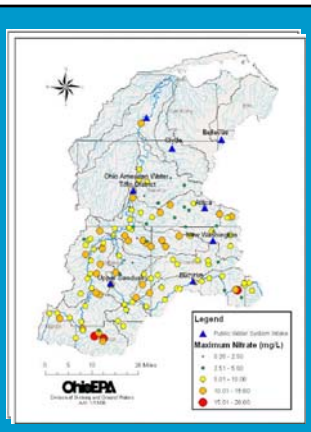


Source: Ohio EPA draft PDWS Beneficial Use Assessment

Annual atrazine spike



Source: Ohio EPA draft PDWS Beneficial Use Assessment



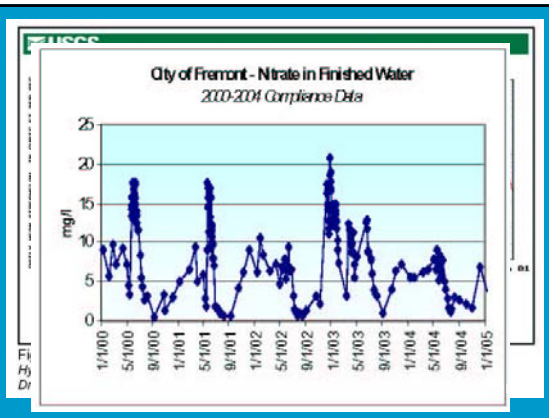
Site-by-site nitrate numbers

Source: Ohio EPA draft PDWS Beneficial Use Assessment

Water quality influences

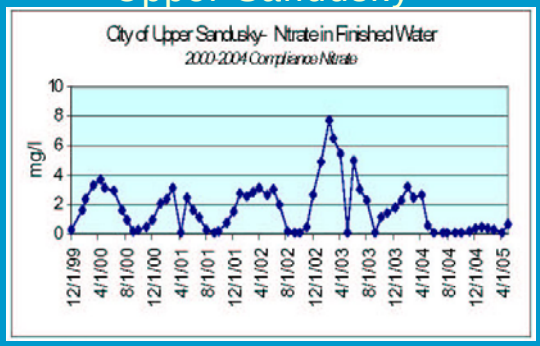
- Seasonality, precipitation events
- Fremont and Tiffin – On-stream reservoirs
- Upper Sandusky, Bucyrus, and others – off-stream reservoirs
- Tiffin blends with ground water
- Upper also has 1 MGD ground water flowing in just upstream

New Washington



Upper Sandusky

Upper Sandusky



Source: Ohio EPA draft PDWS Beneficial Use Assessment

New "Deadwood" reservoir

- Question of programmatic goals at odds
- Water supply vs. wildlife management

Other issues

- Yield reliability – New Washington
- Phosphorus and associated algal blooms
- Turbidity effects on filter performance
- A shortage of Class III/IV water operators necessary to run surface water treatment plants
- Reservoir land, other costs

How would watershed improvement help this situation?

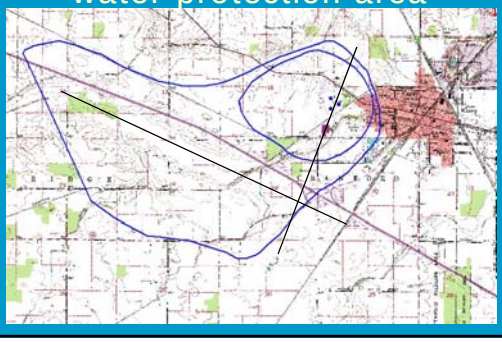
- Improved agriculture and land conservation practices: Reduced N in the source water
- Reduced sediment and thus turbidity
- Reduced difficulty and uncertainty in treatment
- Reduced cost of operation

Ground Water Issues

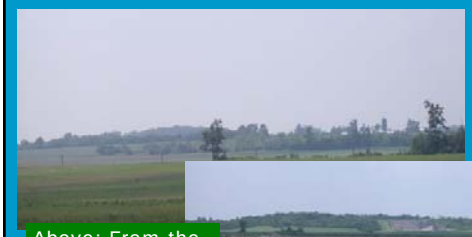
("ground water" is two words)

- Ground water is a significant part of water supply in the Sandusky River watershed
- Private water supply (including non-CWS villages), CWS such as Carey, Sycamore, Nevada, other PWS (schools, etc.)
- Mixed source CWS (Tiffin)
- Baseflow (the river is GW temporarily on the surface)

Carey ground water source water protection area



The Ridge as recharge area



Above: From the east

Right: From west (Blanchard basin)

Weathered shallow carbonate rock

N source in Ridge dolomite?

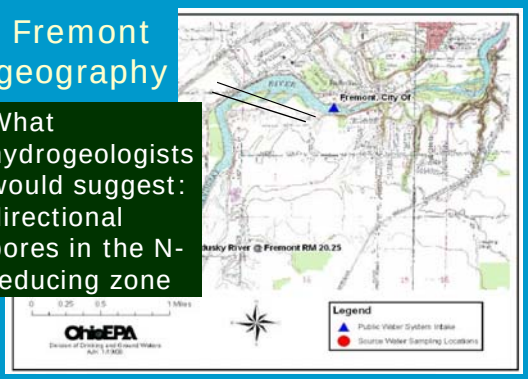
Probably not the "obvious" ones: Needs more study

Shallow bedrock – weathered till

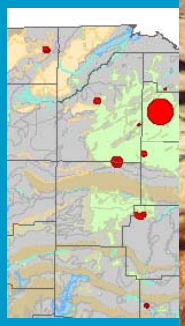
Abandoned shallow SWL well

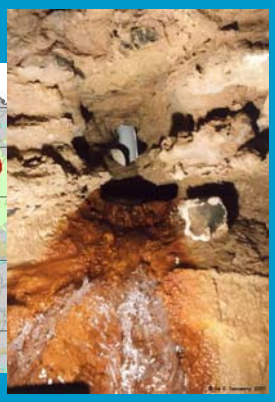
Fremont geography

What hydrogeologists would suggest: directional bores in the N-reducing zone



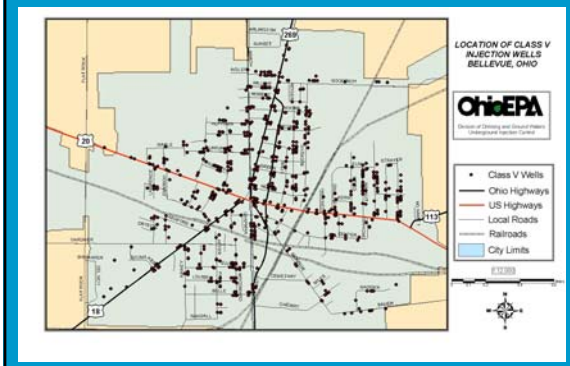
Karst





Map source: Ohio EPA

OK, this is ridiculous…



Questions from an unconventional mind

- Why can't our CWS get New York-style waters
- Curren 19) are too mu rify"
- Why c s and advis ive withou
- What mic, energy changes pose?

"We could have saved the Earth but we were too damned cheap". Kurt Vonnegut Jr

What I like about the coalition:

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Sources of information:

- SRWC website
  - www.sanduskyriver.org
- EPA: Surf Your Watershed
  - www.epa.gov/surf
- Heidelberg Water Quality Lab
  - www.heidelberg.edu/WQL

Chris Riddle
SRWC
419-334-5016
CMRiddle@wsos.org

Stuart Smith, CGWP
Ground Water Science
www.groundwatersystems.com
stusmith@udata.com

The whole world is watching…

(NASA photo)

Note: All opinions expressed are those of the presenter alone

Source Water Protection Goals for Public Water Supplies

Barb Lubberger and Amy Klei
Ohio EPA, Division of Drinking and Ground Waters

June 27, 2006 – Sandusky River Watershed Symposium

Overview

- What are "SWAP goals"?
- Background: Where we've been, Where we're going
- How to meet goals: Protection Plans
- How to meet goals: Drinking water use assessments
- Conclusions

Goals: A piece of the puzzle

Source Water

-high quality source water

No monitoring program

Public Water System

-safe, clean water TO DRINK

Monitored at distribution point—after treatment

Watershed

High quality water for multiple uses:

Aquatic life

Recreation

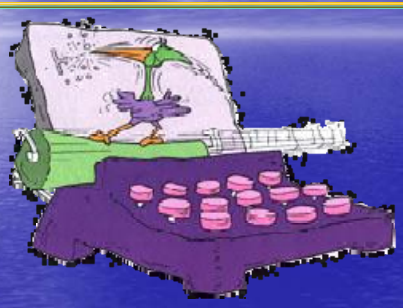
DRINKING

Monitored at selected points throughout watershed

SWAP Programmatic Goals

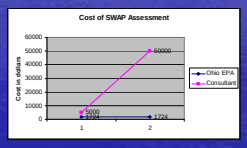
- 50% of high-susceptibility community public water systems will be carrying out 'substantial implementation' of source water protection by 2008.
- NOTE: All surface water systems are high-susceptibility
- NOTE: Most surface water systems are community systems

Where We've Been



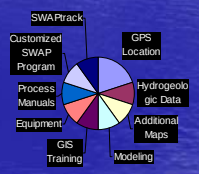
Unit Cost to Public

- By December 31, 2005, about $10 million had been spent since 1998, for 5,800 assessments.
- Unit cost = ~$1,725.
- Consultants charge $5,000 - $50,000



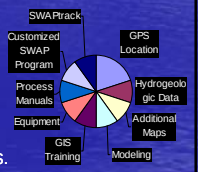
Also included in that $10 million:

- **GPS Location.** Every PWS well in Ohio was GPS-located.
- **Hydrogeologic Data.** A database and statewide GIS shapefile was created of hydrogeologic information from Ohio EPA, USGS, and ODNR
- **Additional Maps.** ODNR created additional Ground Water Resources maps, aquifer maps, Pollution Potential maps, and potentiometric surface maps



Also included ...

- **Modeling.** Numerous Ohio EPA staff trained in ground water modeling.
- **GIS Training.** Numerous Ohio EPA staff proficient in use of ArcGIS.
- **Purchase of equipment.** PCs, software, color printers, etc.
- **Process Manuals.** Process Manuals developed for assessing protection areas.



Where We're Going

Moving from Assessment to Protection

- Protective Strategies Outreach
- SDWA-CWA Integration

SWAP Programmatic Goals

- 50% of high-susceptibility community public water systems will be carrying out 'substantial implementation' of source water protection by 2008.
- 'Substantial implementation' defined as
  --system has an endorsed protection plan
  --system is known to be implementing protective strategies, via SWAP survey or other communication

What is a "Source Water Protection Plan"?

Addresses:

- Education/outreach
- Source Control Strategies
- Contingency Planning
- Monitoring

Education/Outreach

- Organize local "SWAP Planning Team" (under umbrella of Watershed Group, where one exists)
- Consumer Confidence Reports (CCRs)
- SWEETs
- Integration of local source water information into school curriculum ("where does my drinking water come from?")
- Local festivals, river clean-ups, Earth Day events

Source Control Strategies

Similarities:

- SWAP promotes the same BMPs for non-point sources

Differences:

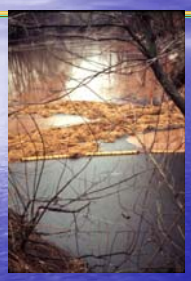
- More focus on USTs and improper disposal from point sources (historically, biggest sources of ground water contamination)
- More focus on sources of volatile organics (most prevalent ground water contaminant).

Source Control Strategies (cont.)

Contradictions:

- Storm water retention ponds in ground water SWAP areas protect surface water but are a potential concern for ground water)
- Agricultural drainage tiles may offer some protection to ground water but are a concern for surface water

Contingency Planning



- "Early warning" networks for chemical spills are in place for surface water systems. Also, major wastewater treatment plants are now required (through NPDES permits) to warn public water systems about CSOs

Recent Incident: Village of Pandora

March 2006: 960 gallons of floor wax from Pandora Manufacturing entered Riley Creek (tributary to Blanchard River) through storm drain. (Village of Ottawa's intake is located 7 miles downstream)

One day later, an employee dumped almost 6,000 gallons of ammonia water down the same drain. (thought it was sanitary sewer drain)

Recent Incident: Village of Pandora

- June 2, 2006: Pandora Manufacturing went up in flames, precipitating a 20-alarm fire.
- Village water tank went dry and pressure dropped in lines, requiring a boil alert.
- Firemen dumped village's 220,000 gallons of water, plus about 130,000 gallons pumped from Riley Creek, onto the fire.
- An unknown portion of Pandora's 500,000 gallons of liquid chemicals escaped into Riley Creek
- All public water systems downstream were notified to watch for plume.

Source Water Monitoring

- For surface water systems, monitoring is used to target protective strategies, and thus plays a key role in SWAP efforts.
- However, monitoring points may be located significant distances from any public water system intake.

"Drinking Water Use Assessment"

- New methodology developed to assess the public drinking water supply beneficial use (draft -Jan 2006)
- Supports regularly monitoring water quality for drinking water within 300 yards of public water system intake.

"Drinking Water Use Assessment"

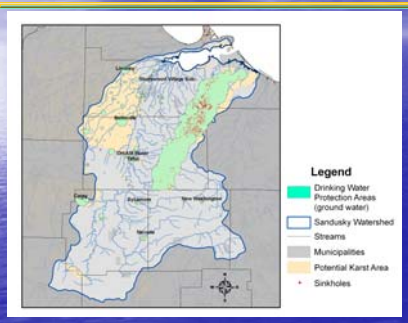
- WQ criteria designed to assure that public water systems using conventional treatment can meet finished water quality standards set by SDWA.
- Focused primarily on nitrate and pesticides but WQ criteria for many other contaminants
- Algae and taste & odor will also be addressed but have not set in-stream criteria yet (chloro-a and nutrients)
- Impairments lead to prioritization for TMDL

Public Water Systems Using Surface Water in the Sandusky River Watershed

From OEPA 2006 PDWS Beneficial Use Assessment Summary Report for the Sandusky River

Sandusky River Watershed-Specific SWAP Goal

- *Surface water-based public water systems within Sandusky River watershed commit to source water protection within context of watershed efforts,*
- *... with plans on paper by 2008.*



Public Water Systems Using Ground Water in the Sandusky River Watershed

... and their protection areas

Sandusky River Watershed: Current Status of Drinking Water Beneficial Use Assessment

- Drafted in 2006
- 8 PWS using surface water included
- Insufficient data for most assessments
  - Source water data needed!
- Two areas IMPAIRED for nitrate
- 4 watch list (nitrate), 2 watch list (pesticides)

Synergies ...

- **Education / Outreach** – can be advanced by working together
- **Source Control Strategies** – can be advanced by working together to manage non-point sources, coordinating where protective strategies collide, and allowing various strengths of SWAP plan and watershed action plan to strengthen the whole.

Synergies (cont.)

- **Contingency Planning** – SWAP-related early warning systems and focus on spills at bridges provides additional protection to Sandusky River and its tributaries, for all their uses.
- **Water Quality Monitoring** –DW Use assessment monitoring provides additional data for entire watershed and another avenue for TMDL prioritization, as well as source water data that SWAP Program has never had.

Conclusions

- Sandusky Watershed Coalition is well-established and in a position to effectively coordinate with public water systems.
- SWAP protection planning for surface water systems should address NPS pollution targeted on reducing nutrients and pesticide levels at the intakes

Conclusions

- **Surface waters near intakes should meet state water quality standards** for Public Drinking Water Supply Beneficial Use
- **SWAP and TMDL efforts should be coordinated,** especially where restoration and protection of drinking water source overlaps

Any Questions or Comments

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Ohio EPA

Div. Of Drinking and Ground Waters
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What are appropriate restoration goals for community partnerships in the Sandusky River watershed?

Or how watershed professionals can perform watershed restoration without being shot by landowners.

Dan Binder, Director of Watershed Programs
The Ohio Environmental Council

What does federal law expect?

- "Evolution of CWA programs over the last decade has also included something of a shift from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies." - USEPA

What does Ohio Law require?

"The ultimate test of success for river restoration activities in Ohio is attaining the aquatic life goals set forth in the Ohio Water Quality Standards and the measurable subcomponents of that process." Yoder

Sandusky River TMDL goals

- **Increase conservation tillage**
- **Increase filter strip coverage**
- **Repair, replace and maintain home septic**
- **Promote best technologies to manage animal waste**
- **Promote filter strips and reduce ditch maintenance**

Rapanos?

- **The Supreme Court ordered the cases returned to a federal appeals court in Cincinnati for more work. Legal scholars believe Monday's decision leaves many questions unanswered. This is likely to lead to new state and federal rules, litigation and legislation around the country.**

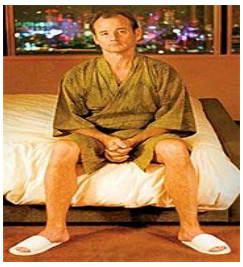
American Farm Bureau

- "The U.S. Supreme Court ruling issued today appears to favor landowners by limiting the regulatory reach of the Clean Water Act to navigable waters and permanent, continuous water bodies. This ruling supports our position as expressed in our friend-of-the-court brief that fields and pastures that have been used by farmers and ranchers for many years should not be regulated the same as rivers and streams."
- - Bob Stallman

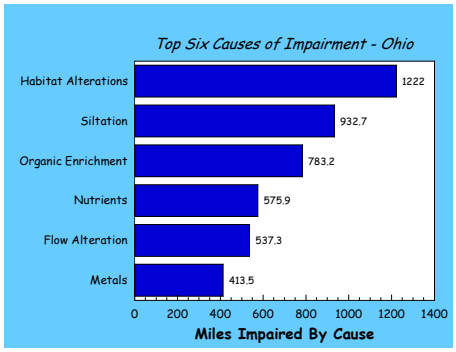
Translating the legal framework to watershed restoration goals

- Water resource integrity
- Biological components
- Chemical and physical goals
- Farm bill goals – EQIP, CREP, WRP
- 319 goals, WRRSP, Clean Ohio
- Foundation goals, GL Collaboration
- County, township, community

Lost in translation

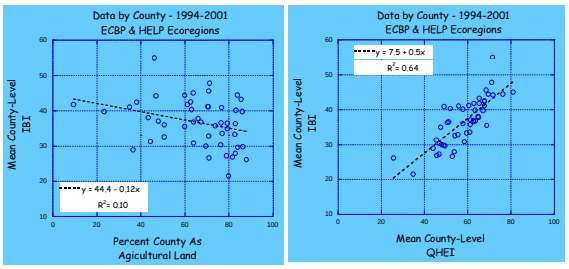


Major impairments to water resources

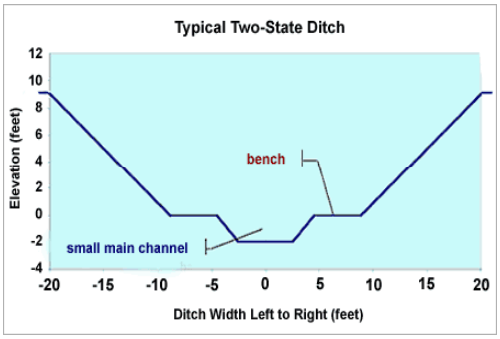


QHEI measures the physical character and integrity of streams and correlates to:

- **Biology and biotic integrity**
- **Ability to assimilate pollutants**
- **Reduced pollutant loads (TP, Nitrate, TSS)**

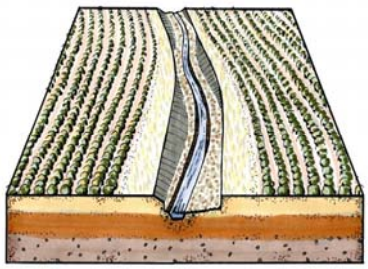


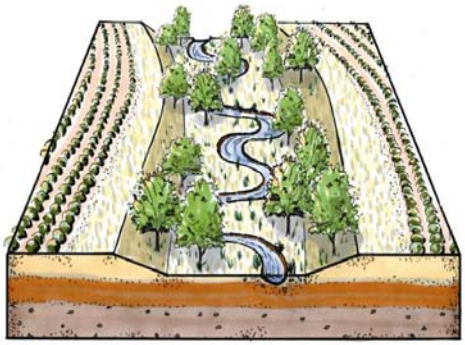
Center for Applied Bioassessment and Biocriteria

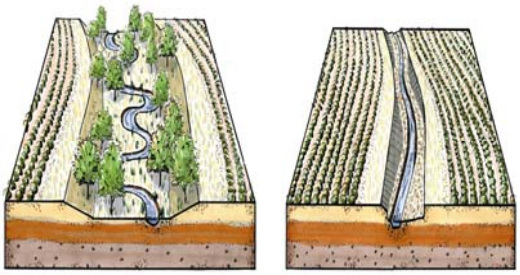


Conclusion

"A two-stage design has been constructed by the Wood County established by Dan Mecklenburg and Andy Ward. Construction has been completed and (will be) evaluating the performance of the design. As part of a new study the water quality benefits of low benches in ditches will be studied. It is anticipated that nitrate exports to the Great Lakes and the Gulf of Mexico might be reduced by retaining or establishing two-stage features in ditches, as well as reducing the long-term cost of ditch maintenance to assessed land owners"







Opportunities for mutual success

- Two stage ditches
- Natural stream channel design
- Naturalizing channels
- Mixed uses and strategies
- One sided maintenance
- Buffers

Other restoration strategies

- Dam removal
- Conservation easements and land trusts
- Zoning including setback ordinances
- Storm water wetland treatment
- 401/404 mitigation

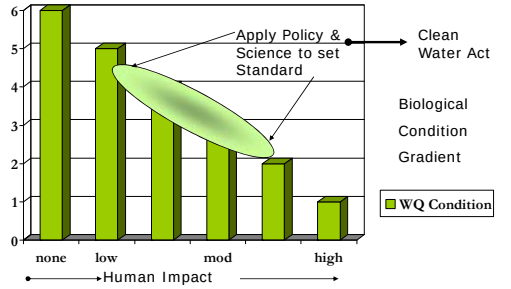
Summary

- View restoration holistically
- Find opportunities to succeed
- Black River Game Club vs Black River Conservation Association
- Foundations, State Funding Programs
- Partnerships

Biological Goals & Use Designations for Sandusky Watershed Streams

How high (or low) to set the bar?

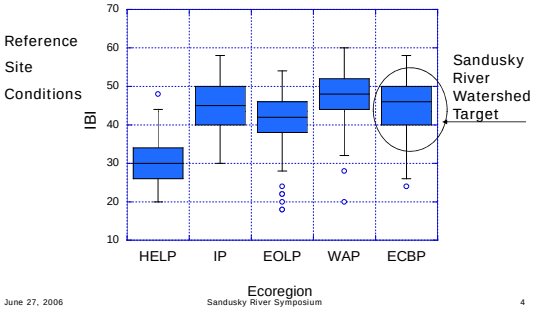
Key Question – How do we know WQ is impaired?



Clean Water Act Goal – Restore & Maintain:

- Chemical, Physical & Biological Integrity
  - Quantify this concept with knowledge of the expected "condition" of fish and benthic community
  - Eco-regionally referenced at "least impacted sites"
- Biocriteria created for the "stair steps" on biological condition gradient
  - Fish
    - Index Biotic Integrity (IBI)
    - Modified Index of Well-being (MIwb)
  - Invertebrate Community Index (ICI)
  - Companion Habitat Tool (QHEI)

Fish IBI scores for Warmwater Habitat



Warmwater Habitat Fish

- grass pickeral
- northern hogsucker
- white sucker
- creek chub
- bluntnose minnow
- central stoneroller
- blackstripe topminnow
- green sunfish
- bluegill sunfish
- longear sunfish
- johnny darter
- greenside darter
- rainbow darter
- orangethroat darter
- fantail darter

Warwater Steam in Madison County

Biological Program Hallmarks

- Standardized sampling and analysis
  - Sampling method influences biocriteria
  - Strong basis for Use Attainability Analysis
- Built in the 1980s with primary application on small to moderate sized streams
- As watershed size approaches 1-3 sq. mi. (perhaps more is some locales?), the sampling methods and the base assumption used to derive biocriteria become less applicable

WQS Fundamentals

Ohio Administrative Code (OAC) Chapter 3745-1

- Three major components:
  - Use designations
  - Water quality criteria
  - Antidegradation

No loss of existing use

- What each component does:
  - Set desired goals
  - Set safe "levels"
  - Basis for permits & TMDLs
  - Keep clean waters clean
  - Tests for "need" to lower water quality

Ohio's Use Designations

Defined in OAC 3745-1-07

- Aquatic Life Uses (ALUs, habitats)
  - Exceptional warmwater - EWH
  - Warmwater - WWH
  - * Modified warmwater - MWH
  - * Limited resource water - LRW
  - * Limited warmwater*
  - Seasonal salmonid - SSH
  - Coldwater - CWH
- Water Supply
  - Public - PWS
  - Agricultural - AWS
  - Industrial - IWS
- Recreation
  - Bathing waters - BW
  - Primary contact - PCR
  - * Secondary contact - SCR

* Requires Use Attainability Analysis (UAA)

Use Attainability Analysis

- Fundamentals
  - Use good science (biocriteria)
  - Use habitat to gage potential
  - Assess cause & affect with multiple indicators
- Administrative
  - Required for all less that "CWA goal" uses
    - Acceptatble reasons include:
      - Impacts of dams, diversions, channelization
      - Natural flow conditions (i.e., ephemeral)
  - Formalize in rule making process

TABLE B-6. Summary of recommendations for use designations in the Big Darby Creek watershed based on a biological and water quality assessment completed in 2000. Symbols are listed for the existing designation/recommended designation (_ - undesignated; + - verified by biosurvey; * - unverified default designation from 1978 or 1985 WQS).

Listed Streams

Default assigned in 1978 by tributary membership

Use assigned by M&A and UAA

Water Body Segment	Use Designations													
		Aquatic Life Habitat						Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Big Darby Creek (02-200)* -			+			+			*+	*+		*+	
			*+										
Flat Branch (02-223) (RM			○			○							
Tributary to Flat Branch (02–365) (RM 1.5)				_+					_+	_+		_+	
Little Darby Creek (02-251) (RM 78.34) RM 3.5 to mouth			+			+			_+	_+		_+	
U.T. to B. Darby Cr. (02-361) (RM 74.91) RM 0.75 to mouth			_+						_+	_+			_+
Spain Creek (02-222) (RM 74.3) - Headwaters to RM 5.0		+	+			+			+	+		*+	
RM 5.0 to mouth			*+			+			+	+		*+	
Pleasant Run (02-221) (RM 72.01)			*+						+	+		*+	

DRAFT: Use of Biological Information to Better Define Designated Aquatic Life Uses in State and Tribal Water Quality Standards: Tiered Aquatic Life Uses – Appendix B – August 10, 2005 172

What WQS apply to "unlisted" waters?

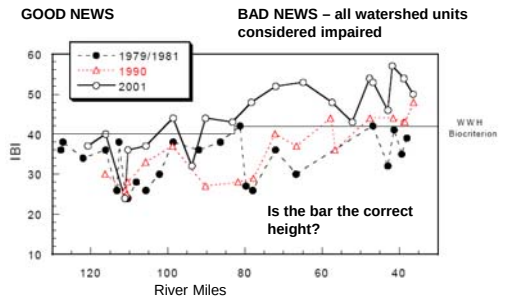
Water bodies not found in use designation rules

- Use designations
  - Probably none (but check default situations)
  - Existing uses protected under antidegradation
- Criteria
  - Aquatic life
    - Chemical numbers same as WWH
    - No biocriteria
  - Human health, wildlife, and aesthetic standards

WQS Uses for the Sandusky River & Tributaries

- Aquatic Life ALU proposal deferred for 21 segments
  - All listed streams Warmwater except:
    - 3 Coldwater segments on tributaries
    - 4 Limited Resource segments on "ditches"
    - 5 Modified Warmwater segments on "ditches"
- Recreational Uses
  - All listed streams Primary Contact except:
    - 10 segments on "ditches"
- Water Supply 2 additional PWS proposed
  - All listed streams Ag. and Industrial plus:
    - 3 short segments Public Water Supply

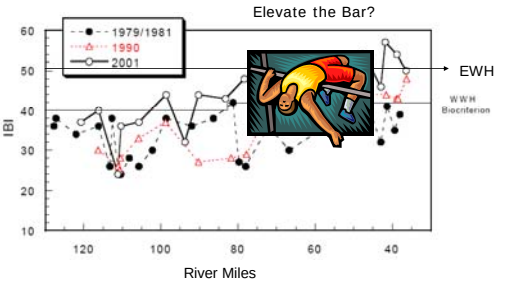
Sandusky River Fish Community Trend



Sandusky River (100 to 1000 sq. mi.)

Location	Fish Score	WQS WWH	QHEI score / QHEI target	Comments UAA Results
Downstream Tiffin RM 36	50	40	1.3	Existing: high WWH Designated: WWH Change
Ella St. Dam pool RM 43	**Modified WWH** 7.3	8.5	**Impounded** 0.9	Existing Designa Change
Bucyrus CSO area RM 111	24	40	0.7	Existing: < WWH Designated: WWH Change: no

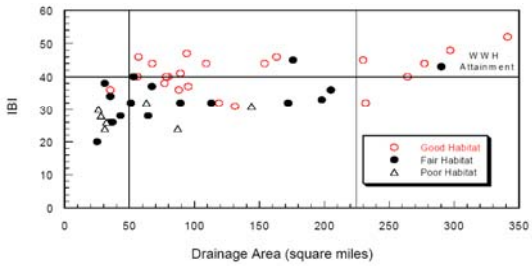
Sandusky River – Future Improvements ?



Larger Tributaries (> 50 sq. mi.)

Location	Fish Score	WQS WWH	QHEI score / QHEI target	Comments UAA Results
Honey Cr RM 6	46	40	1.2	Existing: WWH Designated: WWH 1978 Change: no
Honey Cr RM 15	32	40	1.0	Existing: < WWH Designated: WWH 1978 Change: no
Broken Sword RM 1 **1990**	44	40	1.3	Existing: WWH **(confirmed)** Designated: WWH Change: no
Broken Sword RM 0 - 20 5 sites: **2001**	38 (worst)	40	0.8	Existing: WWH Designated: WWH Change: no

Fish Community Metric vs. Stream Drainage Area

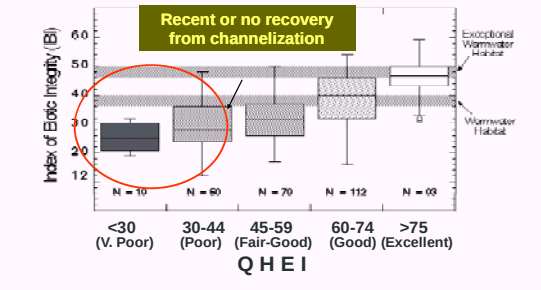


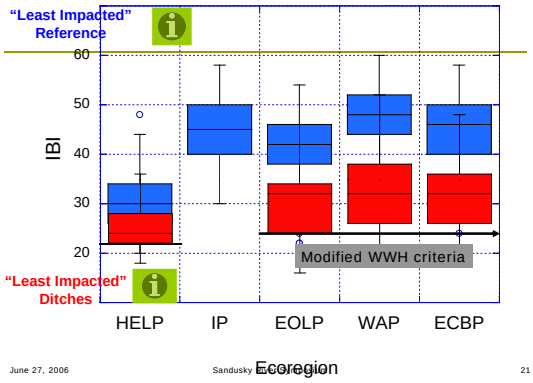
Smaller Tributaries (5 to 20 sq. mi.)

Location	Fish Score	WQS WWH	QHEI score / QHEI target	Comments UAA Results
Broken Sword RM 25 - 30 4 sites: **2001**	26 (worst)*	40	0.3	Existing: < WWH Designated: WWH (1990) Change: Deferred
Indian Run RM 4	28	40	0.5	Existing: < WWH Designated: WWH (1978) Change: Deferred
Honey Creek RM 34	28	40	0.4	Existing: < WWH Designated: WWH (1978) Change: Deferred
Aicholz Ditch RM 4	28	40	0.4	Existing: < WWH Designated: none Change: Deferred

What is Potential for Recovery Under Petition Ditch Laws ?

BIOLOGICAL CONDITION IS CORRELATED WITH HABITAT QUALITY: IBI





ECBP Reference Site

HELP Reference Site

Typical Least Impacted Ditches

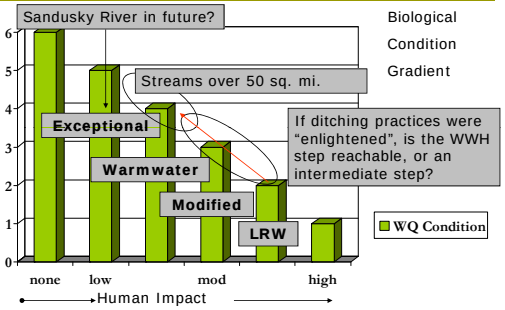
Impacted Ditches

Restoration Potential?

Powderlick Run, Restored Portion

Overwide Channel - "accident"

Where do we set the targets?



Thank You

Dan Dudley

Manager, Standards & Technical Support Section

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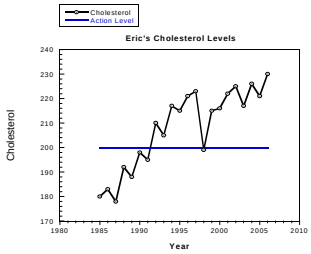
644-2876

Sandusky TMDL: Goals for Phosphorus Load Reductions

Presented by Eric Piñeiro, Ohio EPA
Sandusky River Watershed Symposium
June 27, 2006

Importance of Setting Goals

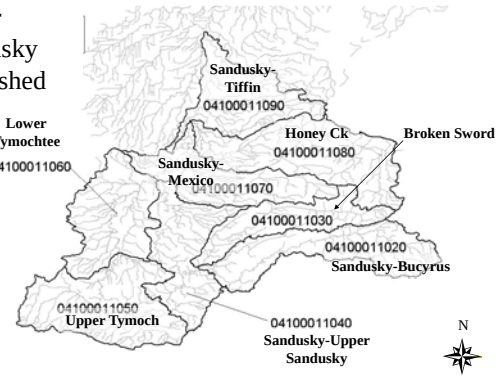
- Analogy: Cholesterol level in bloodstream



Ultimate TMDL Goal: Meet Appropriate Use Designation

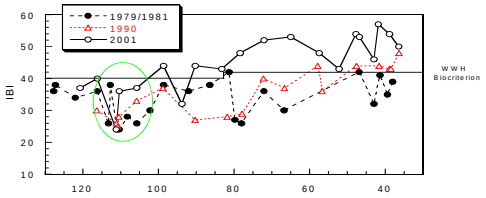
- How is this Achieved?
- Locate Problem Areas
- Determine Causes and Sources of the impairment
- Measure or estimate the pollutant loads
- Set goals for pollutant reduction and habitat enhancement that will help stream meet the biological criteria

Upper Sandusky Watershed

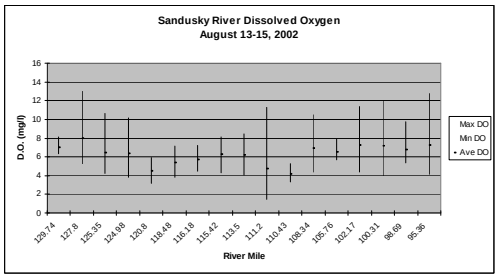


Looking for Problem Areas

Ohio EPA Fish Score Results in Sandusky River: 1979, 1990 and 2001 Surveys



Impact of Phosphorus and Nutrients



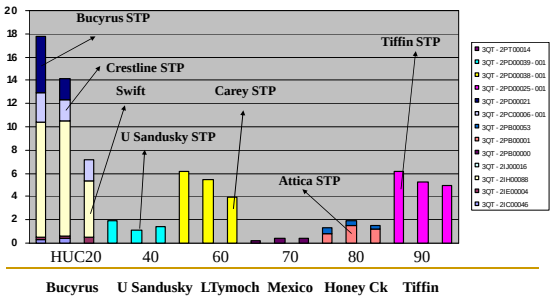
Some Sources are Obvious…

Total Phosphorus: 17 mg/l in this effluent

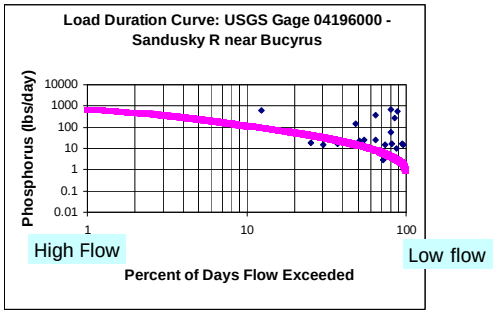
Small Sources Add Up in Small Streams

- CBOD20 = 130 mg/l
- chloride = 663 mg/l
- NH3-N = 27.9 mg/l
- total P = 4.6 mg/l

Summer Total Phosphorus Loads (kg/d) from Point Sources in Sandusky River Basin (by Assessment Unit) 1998-2000



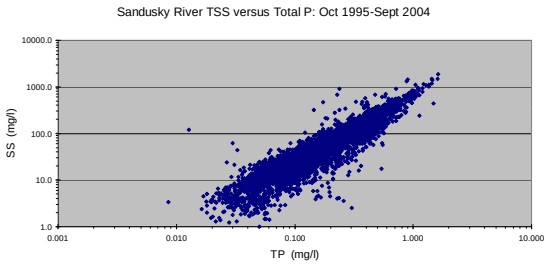
Is it a Point Source or Non-Point Source Problem?



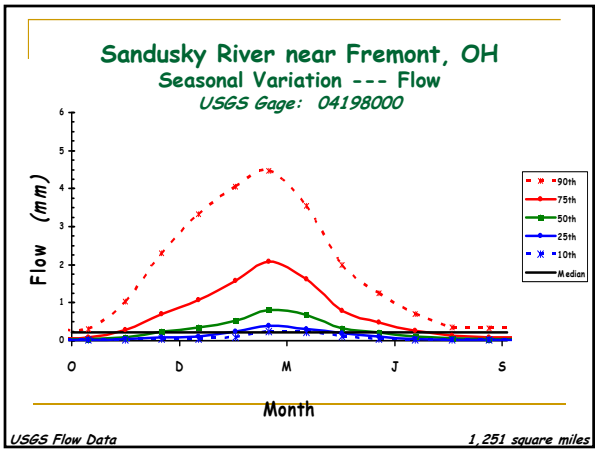
Influence of Rain/Streamflow

- Sediment and Phosphorus loads from cropland are larger during wet years
- High flows transport larger pollutants loads, erode banks, pollute Lake Erie
- At low flow conditions, small dischargers have local impact due to lack of dilution

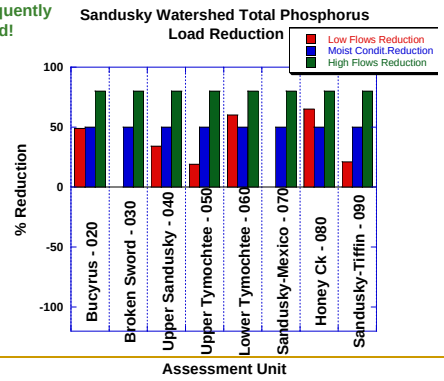
Problem With Runoff…



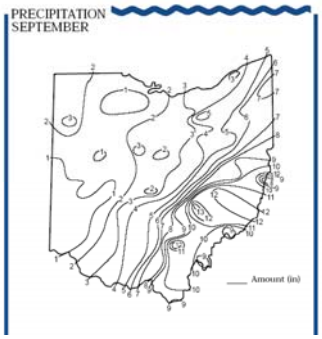
Phosphorus-laden Silt is Transported to Lake Erie



Were subsequently Revised!



Climate Change Complication: Remnants of Hurricanes can bring Excessive Precipitation to Ohio



Achieving Load Reduction Goals:

- Tackle the obvious sources first (CSOs, outfalls) if considered significant

How to Achieve the Phosphorus Load Reductions…

Cover exposed soil to prevent erosion during construction projects

Apply fertilizer / manure at reasonable rates, and watch the weather

How to Achieve the Phosphorus Load Reductions…

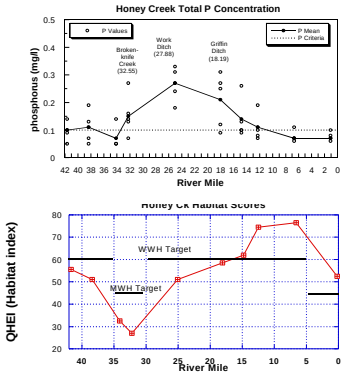
Fence livestock off the streams

How to Achieve the Phosphorus Load Reductions

- Repair or replace Faulty Septic Systems

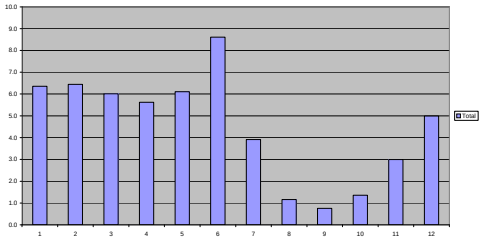
How to Achieve the Phosphorus Load Reductions…

Improve Habitat to Increase the Streams' Assimilative Capacity



How to Achieve the Phosphorus Load Reductions…

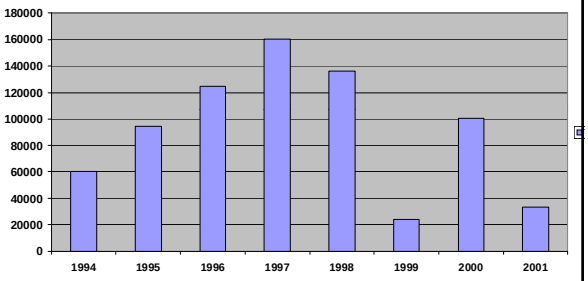
Keep in mind the seasonal variations during implementation



How to Achieve the Phosphorus Load Reductions…

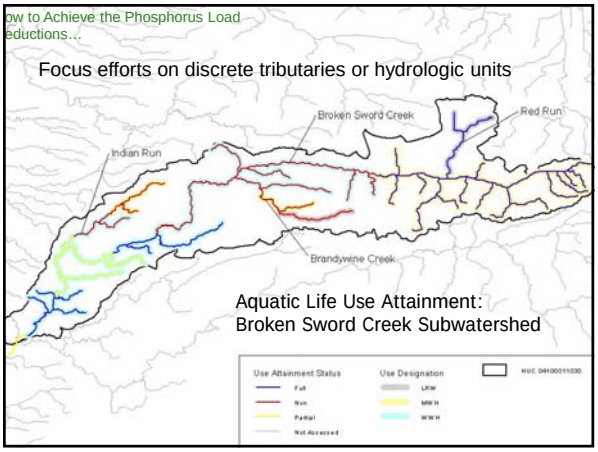
Monitor Progress and make adjustments

Annual Load of Total Phosphorus (lbs): Honey Creek at Melmore



How to Achieve the Phosphorus Load Reductions…

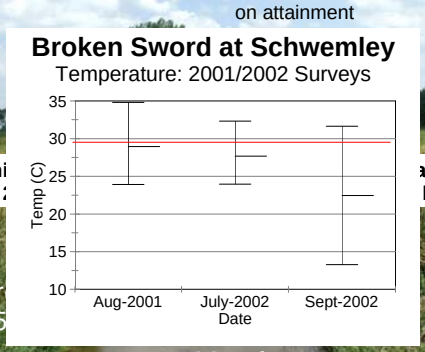
Focus efforts on discrete tributaries or hydrologic units



Aquatic Life Use Attainment: Broken Sword Creek Subwatershed

How to Achieve the Phosphorus Load Reductions…

Influence of high temperature on attainment



Maximum Temperature WQS Violations at RM 25.5

Achieving Pollutant Load Reductions

- Strive to come up with your individual "load" reduction, no matter how small.
- Promote a culture of minimal use, instead of excess
- Think about the people using the water downstream from you
- Assume that resources won't last forever

Ohio EPA

- For more information contact:
- Eric Piñeiro
- 614-644-2886

Dr. Larry C. Brown

Professor, Extension Agricultural Engineer

Department of Food, Agricultural, and Biological Engineering

The Ohio State University

brown.59@osu.edu

Agricultural Water Management web site:
www.ag.ohio-state.edu/~agwatmgt/

Managing Agricultural Drainage Systems

for Water Quality Improvements

in the Midwest

Source areas of N to Gulf of Mexico

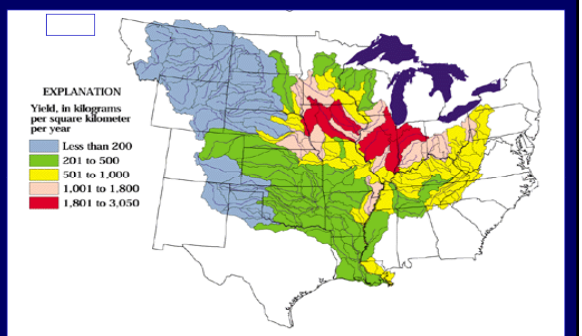
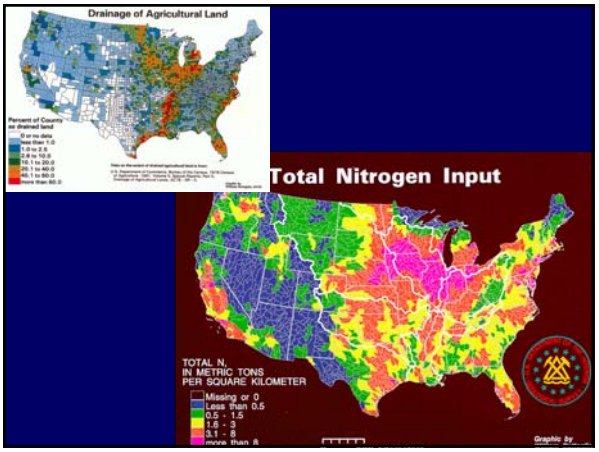
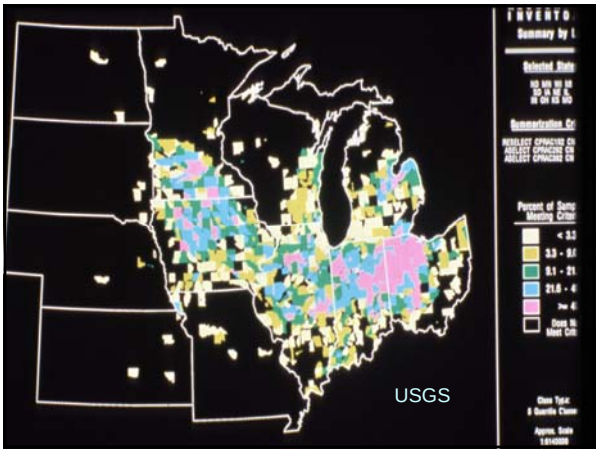
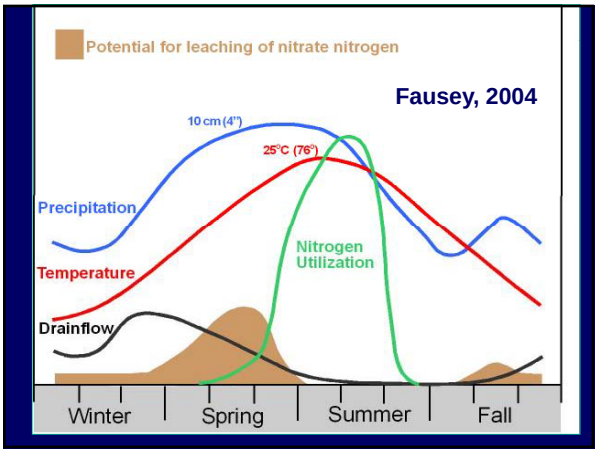


Figure 6. *(A)* Nitrogen inputs during 1992 and *(B)* average annual nitrogen yields of streams for 1980–96 (modified from Goolsby and others, 1999).







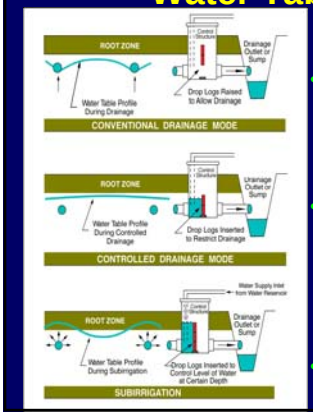
Midwest Agricultural Drainage Systems Management Initiative

- Primarily focused on agricultural subsurface drainage and nitrate-nitrogen loading to surface waters
- Practices include:
  - Controlled drainage (Drainage Water Management)
  - Shallower drains spaced closer together
  - Biofilter drains
  - Constructed wetlands, others

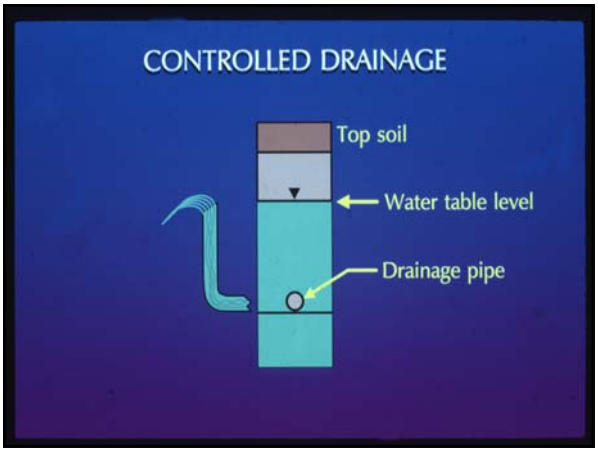
USDA-NRCS Practice Standard 554 (available on NRCS Website)

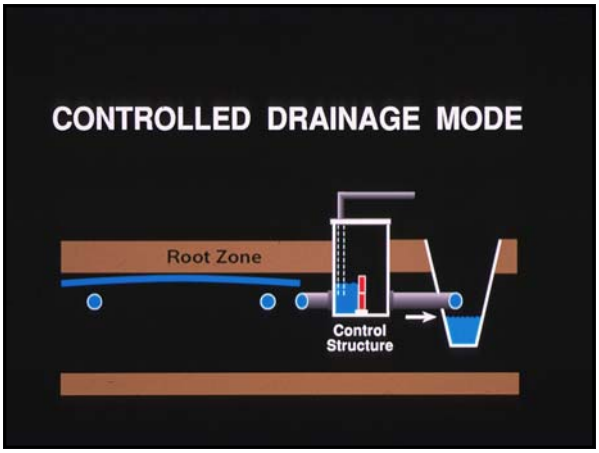
- Drainage Water Management
- National Standard
- Modified and then accepted by each state
- Primary focus has been Midwest
- Ohio standard in review
- Ohio manure standard addresses drainage water management as well
- 554 practice will be supplemental EQIP practice for buffers in CREP watersheds, Scioto River Basin, Lake Erie Basin, others

Water Table Management

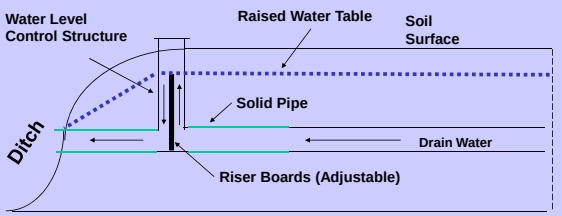


- Conventional Drainage
- Controlled Drainage
- Subirrigation

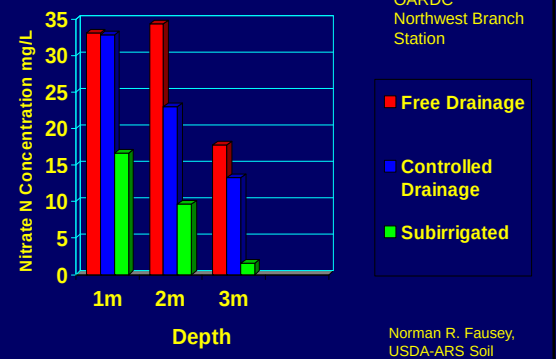




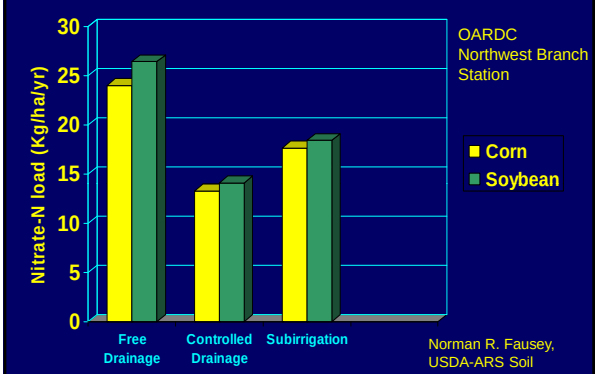
Drainage Management Control Structure is Placed in Drain Line (Modified from D. Pitts, NRCS, IL)



The water level control device is installed in the drain near the outlet and at various locations within the field depending on topography



Norman R. Fausey,
USDA-ARS Soil
Drainage Research Unit



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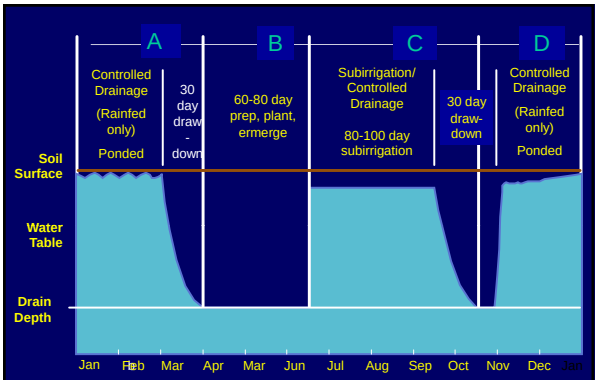
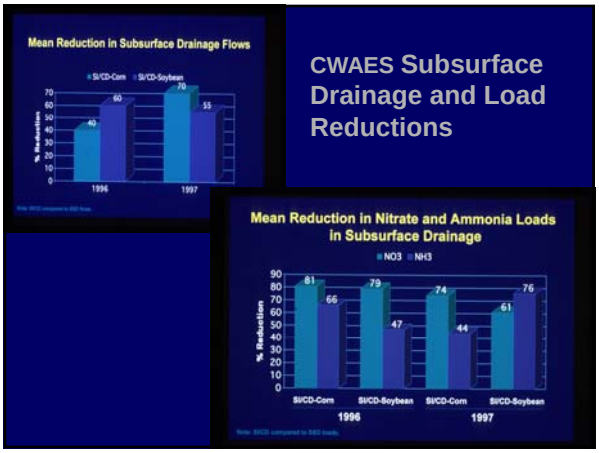


Hydrology of Controlled Drainage/Subirrigated System

(CWAES – USDA-ARS-SDRU & OSU-FABE/Soil Ecology)



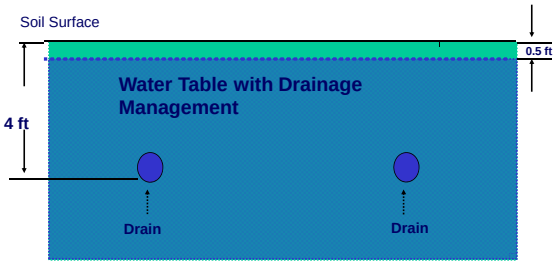
CWAES Subsurface Drainage and Load Reductions

We expect a 50% reduction in Annual Nitrate Loads, on average, by Managing Agricultural Drainage Systems on appropriate sites in Ohio

Change in Outflow Volume

Minimal change in Concentration

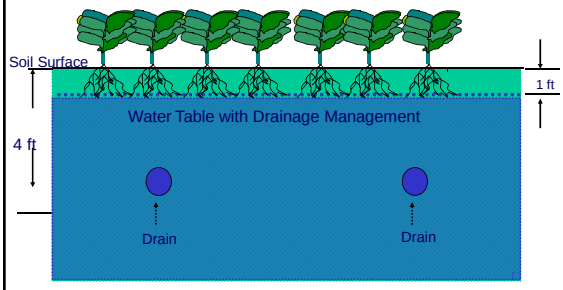
Fallow Season Drainage Management (From D. Pitts, Il NRCS)



Water table is managed so that water table can rise above drains

Production Season Drainage Management

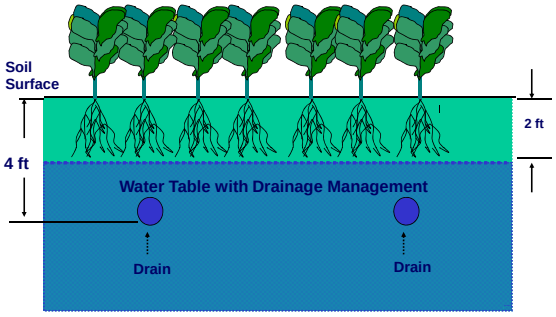
(when plants are young) **(From D. Pitts, Il NRCS)**



Water table is lowered by ET and seepage as root system develops

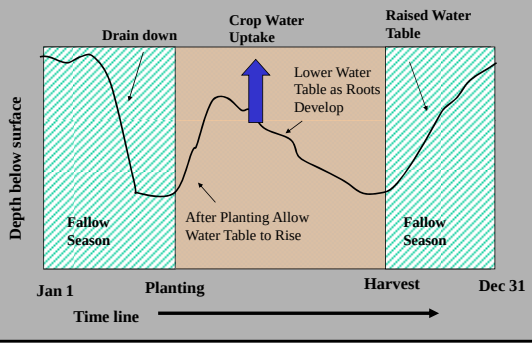
Production Season Drainage Management

(when plants are older) (From D. Pitts, Il NRCS)



Water table lowered as root system develops

Water Table Level with Drainage Management (from D. Pitts, NRCS, IL)



Defiance County Site (1990)

Controlled Drainage Conversion

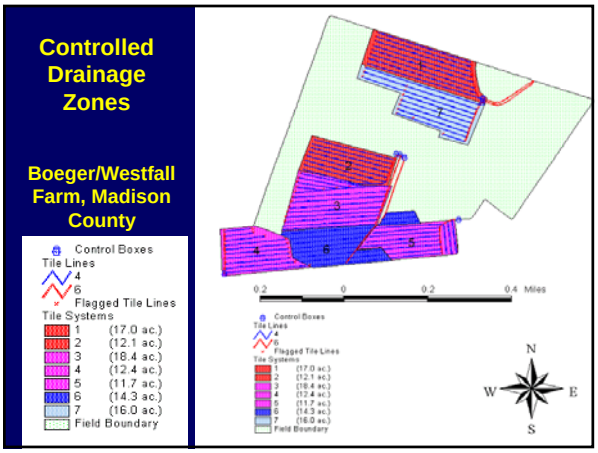
WRSIS Ohio Sites in Fulton, Defiance, Van Wert, Champaign counties

Michigan Site in Lennawee County (Northcott)

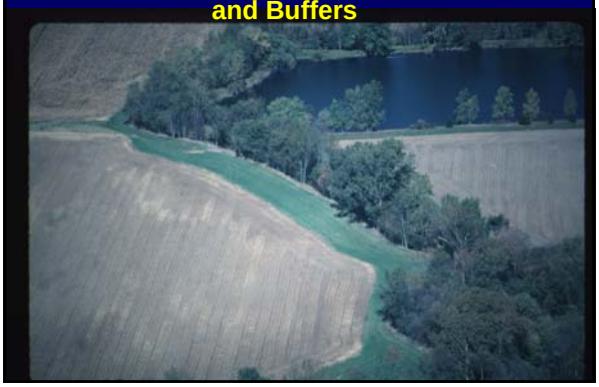
TNC Site in Illinois

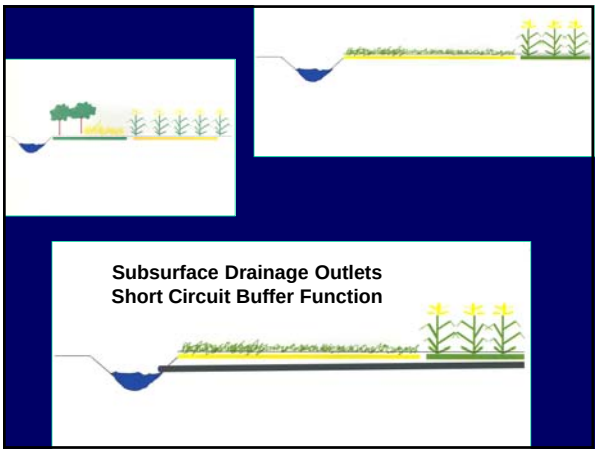
Controlled Drainage Zones

Boeger/Westfall Farm, Madison County



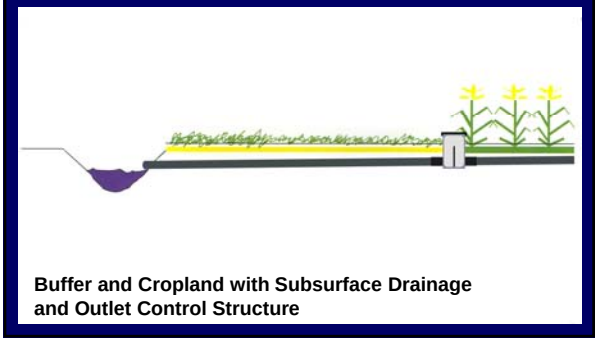
Subsurface Drainage, Filter Strips and Buffers





Conservation Buffers:

Controlled Agricultural Drainage
CREP Supplemental Practice for Scioto Watershed



Buffer and Cropland with Subsurface Drainage and Outlet Control Structure

Targeted Watersheds

CIG Project Proposals on Drainage Water Management

- Scioto
- Upper Great Miami
- Western Lake Erie
- Upper Maumee
- Grand Lakes, St. Marys
- Huron
- Sandusky
- others

Opportunities

On-Line Resources

http://www.ag.ohio-state.edu/~agwatmgt/\

Agricultural Drainage: Water Quality Impacts and Subsurface Drainage Studies in the Midwest, Bull. 871

http://ohioline.osu.edu/b871/index.html

Understanding Agricultural Drainage AEX 320-97

http://ohioline.osu.edu/aex-fact/0320.html

Agricultural Water Table Management Systems AEX 321-97

http://ohioline.osu.edu/aex-fact/0321.html

Farm Science Review 2006

- September 19-21
- Ohio Land improvement Contractors Association
- Conservation Construction Field Days
- Drainage Installation, Drainage water Management, Drainage Outlets, Waterways, etc.

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The Ohio State University

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Agricultural Water Management web site:
www.ag.ohio-state.edu/~agwatmgt/

Precision Farming

- The Title is a Misnomer
- Precise to a Degree

- **Technology Continues to Evolve**
  - 1. Equipment
  - 2. Software
  - 3. Integration with Machinery
  - 4. Reports and Records

Production Uses Continue to Develop

1. Field Boundaries
2. Soil Type Maps
3. Crop Histories
4. Nutrient Maps
5. Variable Rate Application
6. Yield Maps
7. Manure Management
8. RTK Steering

Who Benefits from this type of Management

1. Farmer
2. Consumer
3. Environment

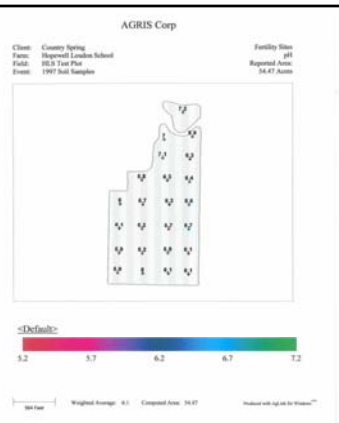
Country Spring Farmers Co-op

Hopewell Loudon School

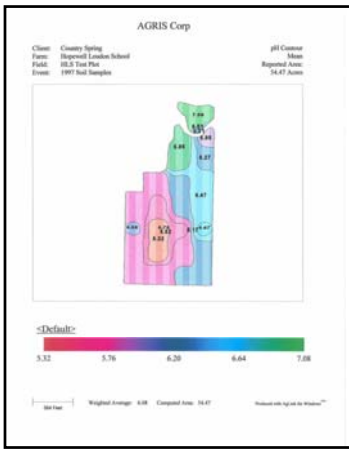
Grid Soil Sampling Maps

1997 pH Levels
1997 pH Contour Map
Lime Rates-East & West
2001 pH Levels
1997 P1 Levels
1997 K Levels
1997 Variable Rate K map

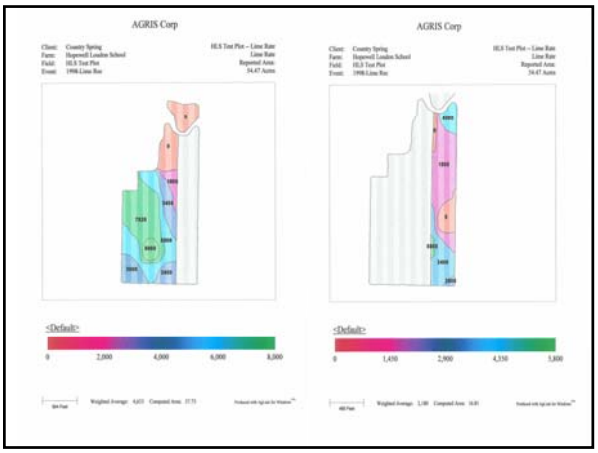
Break-Down of Fertilizers spread in 1997

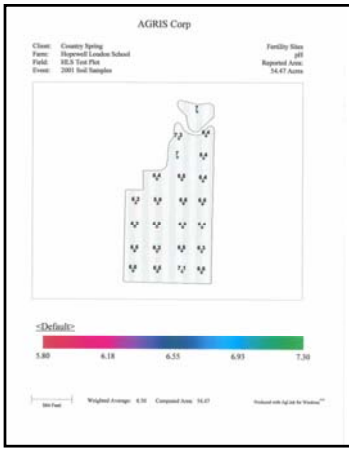


1997 pH Levels

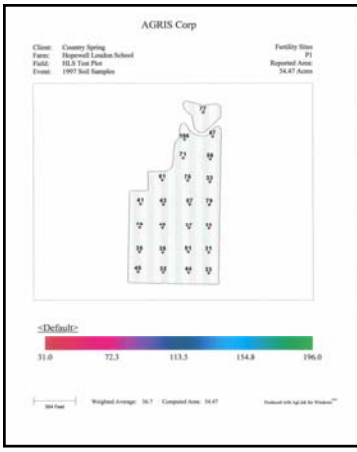


1997 pH Contour Map

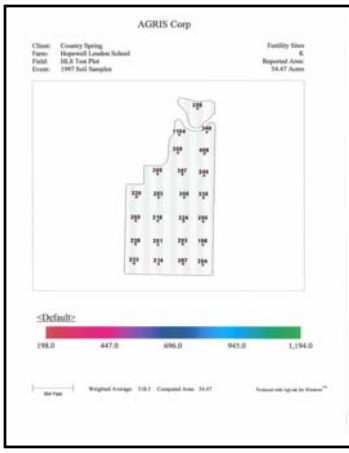




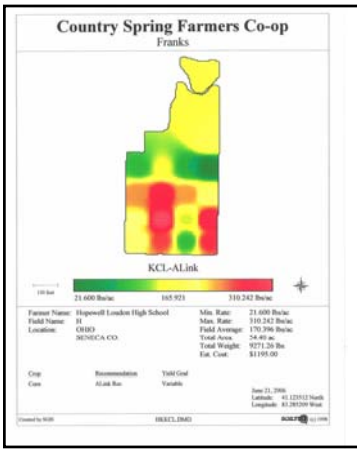
2001 pH Levels



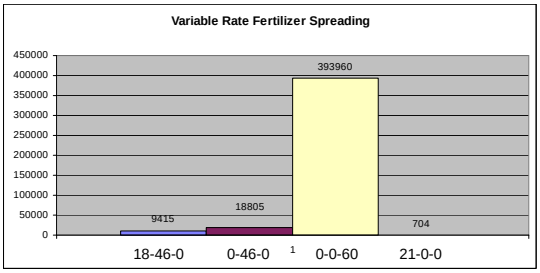
1997 P1 Levels



1997 K Levels



Variable Rate K Map


Variable Rate Fertilizer Spreading
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
9415
18805
393960
704
18-46-0
0-46-0
1
0-0-60
21-0-0

THE LAKE ERIE BUFFER PROGRAM

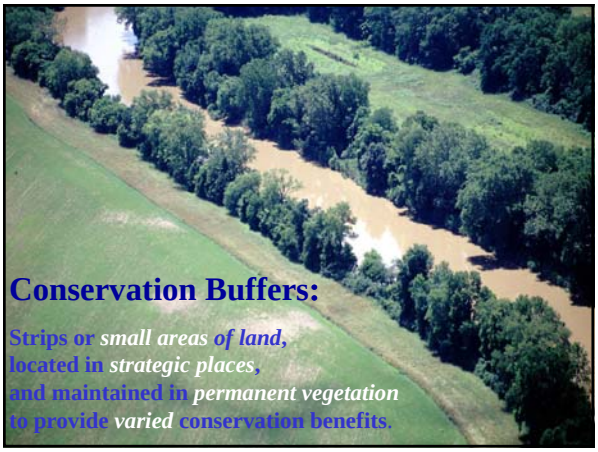
LAKE ERIE BUFFERS

A Partnership to Improve Our Great Lake…

Lake Erie Buffer Team Mission

The Ohio Lake Erie Buffer Program is guided by a team of public and private agricultural and natural resource organizations, which encourages farmers and landowners to implement conservation buffer technologies that protect Ohio's soil and water resources.

What Are Conservation Buffers…?

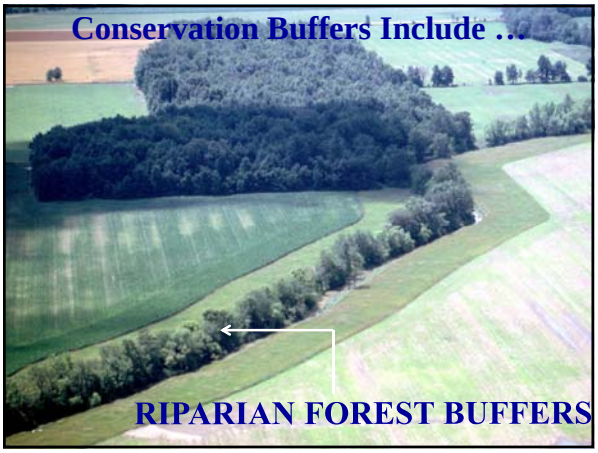


Conservation Buffers:

Strips or *small areas of land*,
located in *strategic places*,
and maintained in *permanent vegetation*
to provide *varied* conservation benefits.

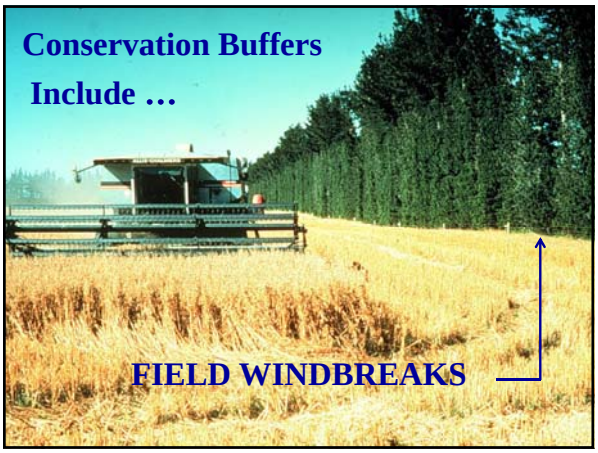
Conservation Buffers Include …

GRASS FILTER STRIPS

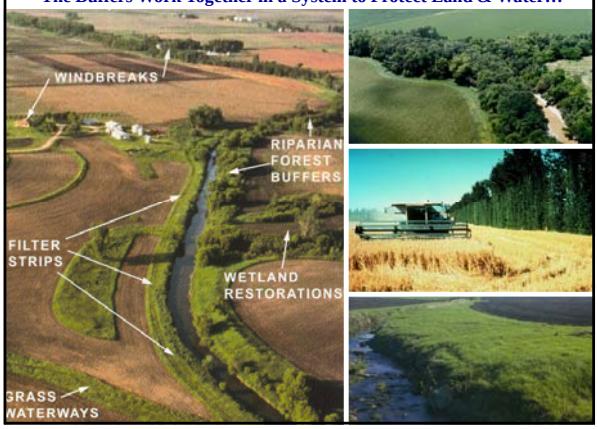


Conservation Buffers Include …

RIPARIAN FOREST BUFFERS



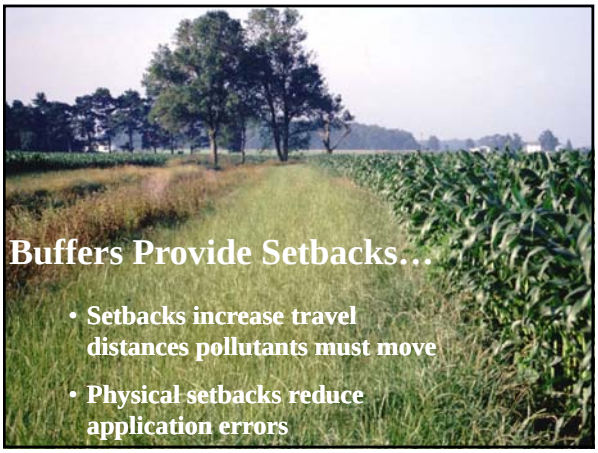
The Buffers Work Together in a System to Protect Land & Water…

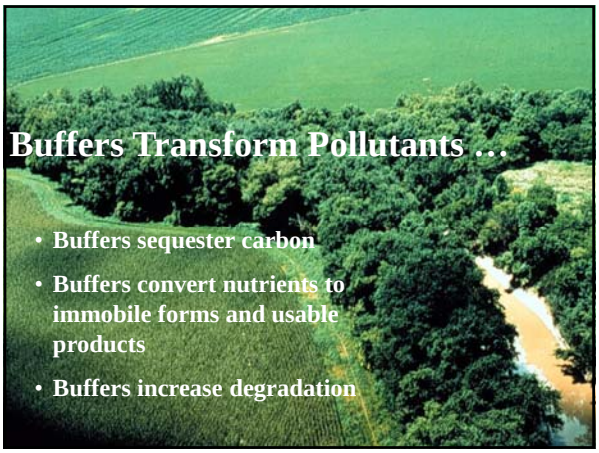


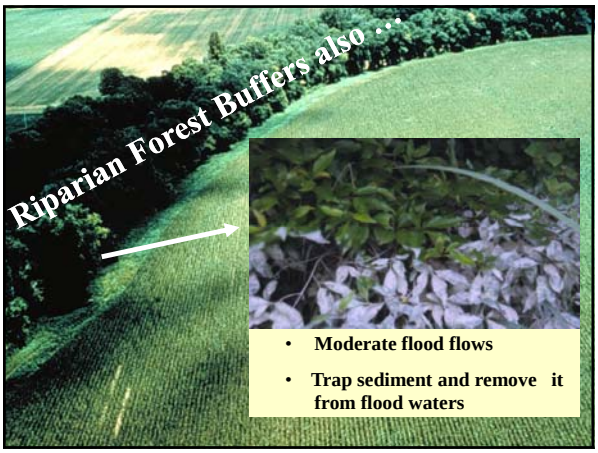
Functions Of

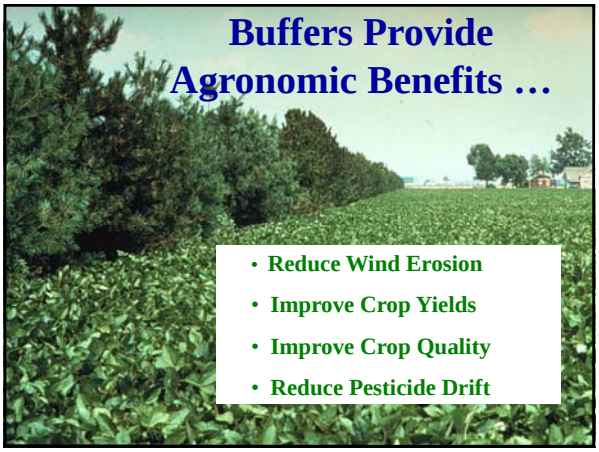
LAKE ERIE BUFFERS

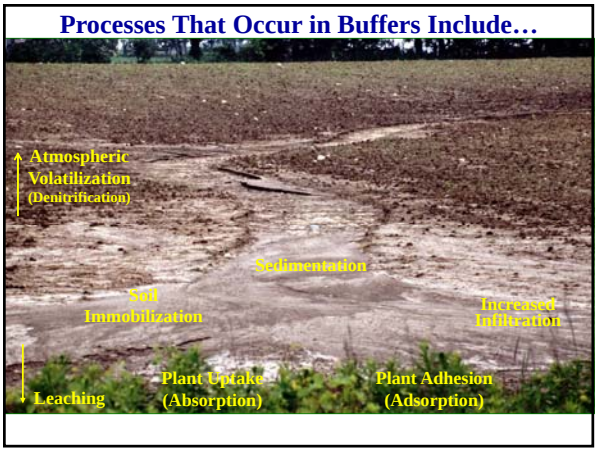
Conservation Buffers

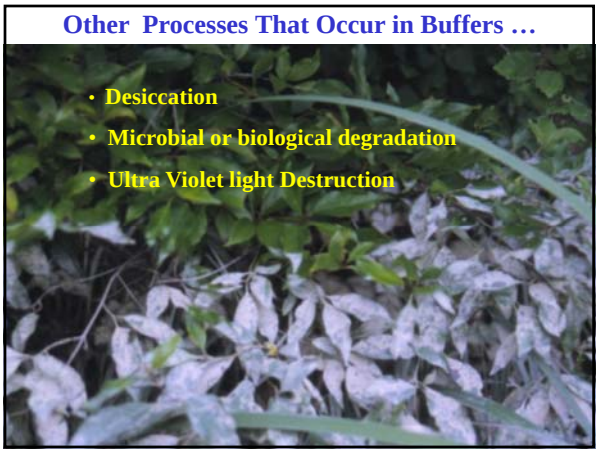












Effectiveness Of

LAKE ERIE BUFFERS

Conservation Buffers

Reduction of Sediment By Grass Filter Strips

Strip Width	Per Cent Reduction	Study
35 m	71%	Peterson, et a. 1980)
4.6 m	74%	Dillaha, et al. (1989)
9.1	87%	"
4.6 m	72%	Magette, et al. (1987)
9.2	86%	"
4.6 m	81%	Dillaha, et al. (1988)
9.1 m	91%	"

Reduction of Nitrogen By Grass Filter Strips

Strip Width	Per Cent Reduction	Study
4.6 m	63% (total n)	Dillaha, et al. (1989)
9.1	76%	"
4.6 m	17% (n)	Magette, et al. (1987)
9.2	42%	"
.5 m	0% (soluable n)	Doyle, et al. (1977)
1.5 m	57%	"
4.0	68%	"

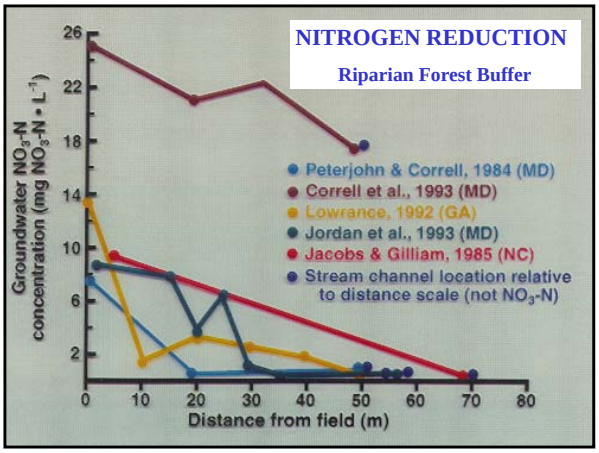
Reduction of Phosphorous By Grass Filter Strips

Strip Width	Per Cent Reduction	Study
4.6 m	69% (total p)	Dillaha, et al. (1989)
9.1	82%	"
4.6 m	51% (p)	Magette, et al. (1987)
9.2	53%	"
.5 m	9% (soluable p)	Dillaha, et al. (1977)
1.5 m	8%	"
4.0	62%	"

Reduction of Poultry Litter Contaminants

	Filter Strip length (meters)				
	3.1	6.1	9.2	15.2	21.4
	% reduction				
TKN	39%	53%	67%	76%	81%
NH_3-N	47	70	78	94	98
TP	37	54	74	87	91
$P0_4$-P	39	55	71	85	90
TSS	35	35	35	35	35

Chaubey, et al., (1995)



Benefits Of Buffers……

LAKE ERIE BUFFERS

To Farmers and Landowners!

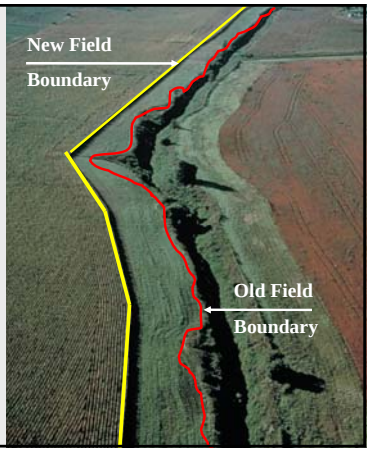
Buffers allow access to remote fields for scouting and harvesting purposes.

Buffers eliminate end rows and provide places to park wagons at harvest.

Buffers Straighten Field Boundaries

and

Make Planting & Harvesting More Convenient!



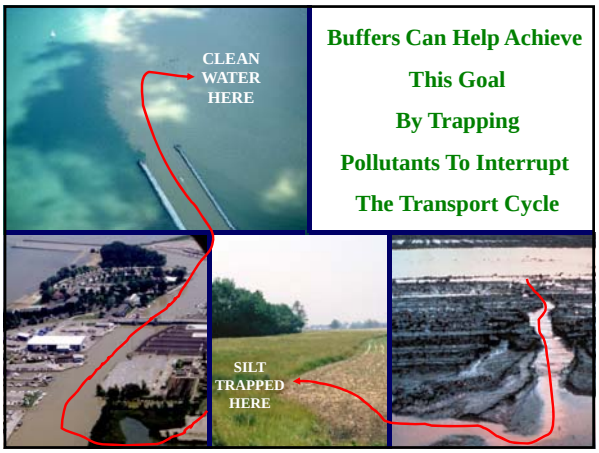
Buffer programs provide income from areas where crops are commonly lost or damaged.

Benefits Of Buffers……

LAKE ERIE BUFFERS

To The Environment!

Sediment is the primary non-point pollutant concern in Lake Erie…..

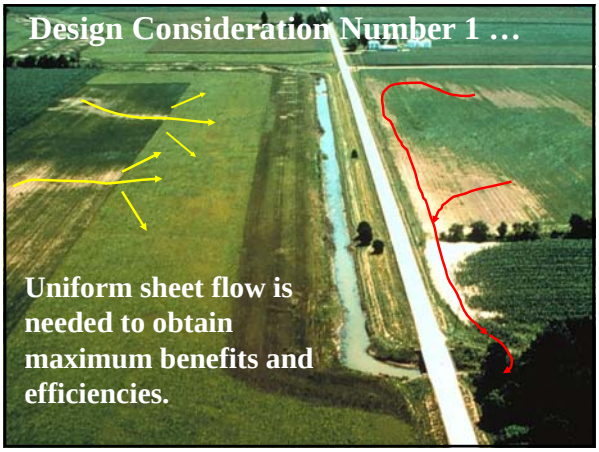


Buffers Can Help Achieve This Goal By Trapping Pollutants To Interrupt The Transport Cycle

Design Considerations

LAKE ERIE BUFFERS

For Conservation Buffers



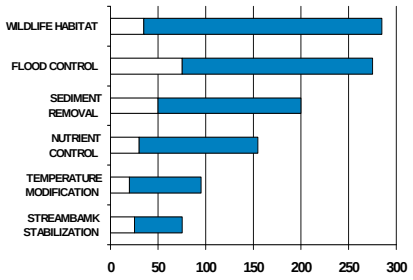
Design Consideration Number 1 …

Uniform sheet flow is needed to obtain maximum benefits and efficiencies.

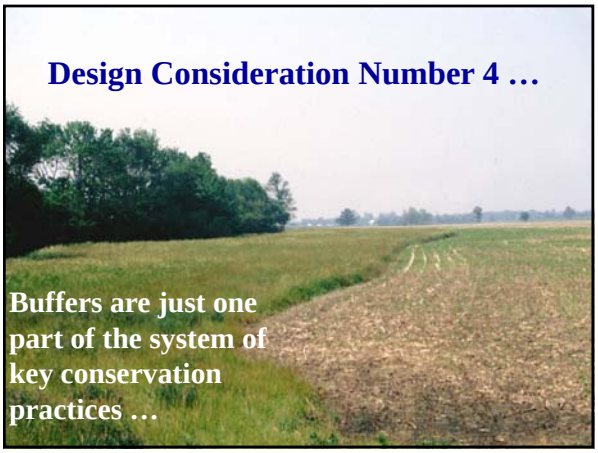
Design Consideration Number 2 …

Even narrow strips can provide substantial benefits …

Design Consideration Number 3 …



The wider the strip the more the benefit, both for a single purpose and multiple purpose …



Design Consideration Number 4 …

Buffers are just one part of the system of key conservation practices …

Programs with Financial Incentives

LAKE ERIE BUFFERS

To Establish Conservation Buffers

CONSERVATION RESERVE PROGRAM

CONTINUOUS CRP

- 10 or 15 Year Contract Lengths
- 120% of Normal CRP Soil Rental Payment
- $100 or $140 First Year Bonus Payment
- Reimbursement for 90% cost of practice
- Choice of grass, trees, windbreaks

USDA UNITED STATES DEPARTMENT OF AGRICULTURE

LAKE ERIE Conservation Reserve Enhancement Program

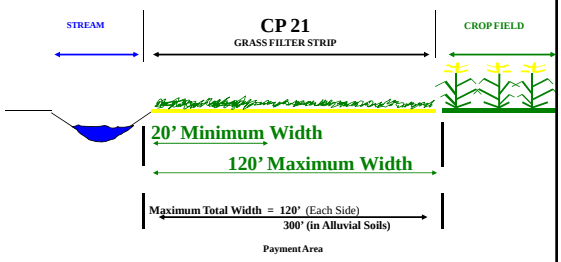
C·R·E·P

ODNR, SWCDs & USDA helping landowners protect the region's natural resources

- 20 or 30Year Contract Lengths
- 155% of Normal CRP Soil Rental Rate - (grass)
- 175% of Normal CRP Soil Rental Rate - (trees)
- $340 to $640 First Year Bonus Payment
- Reimbursement for 90% cost of practice
- Choice grass, trees, windbreaks, wetlands, or wildlife habitat.

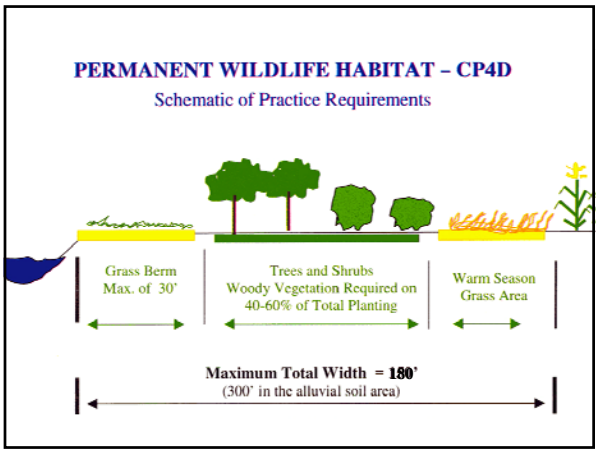
CRP & CREP GRASS FILTER STRIPS

Practice Code CP21

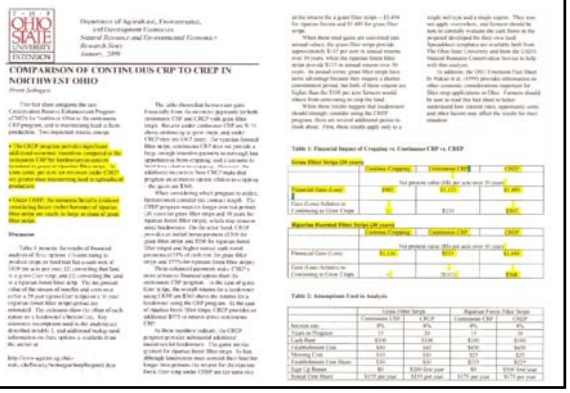


CRP & CREP RIPARIAN FOREST BUFFERS

Practice Code CP22



An Ohio State University Economic Fact Sheet Confirms the Economic Benefits of Program Participation …


COMPARISON OF CONTINUOUS CRP TO CREP IN NORTHWEST OHIO

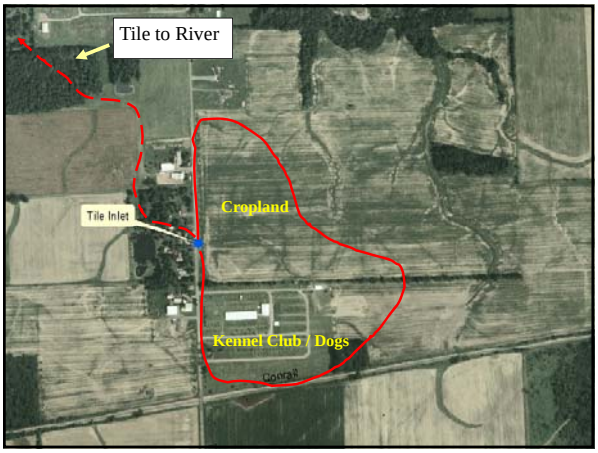
Proposed Lake Erie CREP

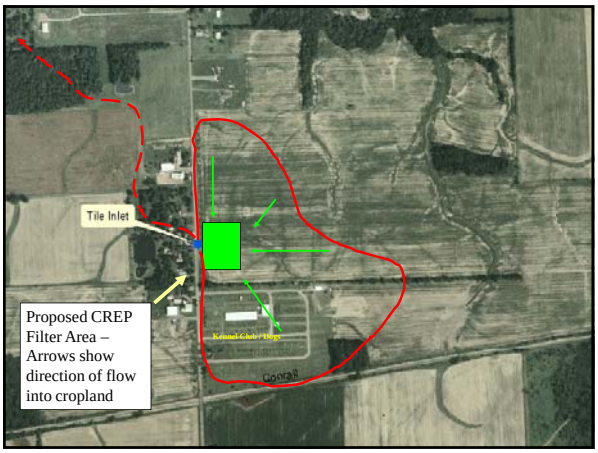
LAKE ERIE
Conservation Reserve
Enhancement Program

ODNR, SWCDs & USDA
helping landowners protect
the region's natural resources

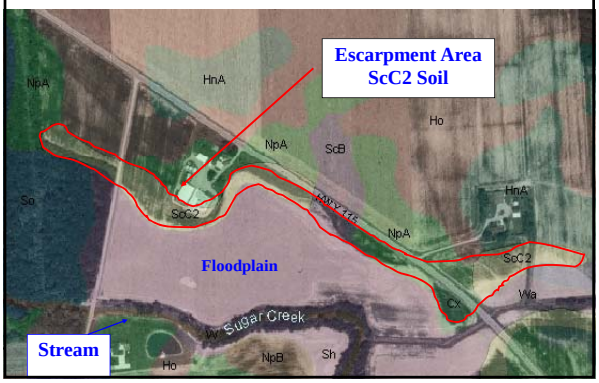
Enhancements

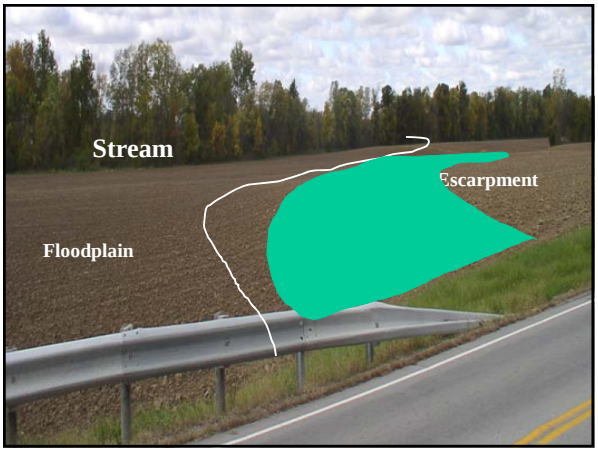
New Lake Erie CREP Filter Area Practice





New Lake Erie CREP Escarpment Practice



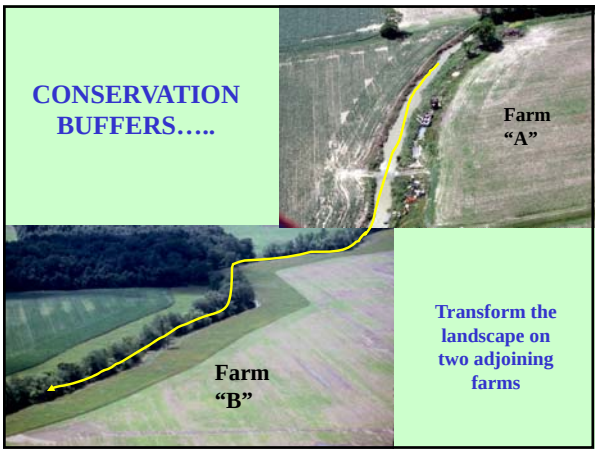


LAKE ERIE Conservation Reserve Enhancement Program
ODNR, SWCDs & USDA helping landowners protect the region's natural resources

Proposed CREP Changes

Practice	Existing Payment (% of Soil Rental)	Proposed Payment (% of Soil Rental)	Additional Details
Filter Strips	155%	155% Cool S. 175% Warm S.	15 Year Contract
Filter Areas	NA	155% Cool S. 175% Warm S.	15 Year Contract
Escarpments	NA	155% Cool S. 175% Warm S.	15 Year Contract
Riparian Trees	175%	225%	15 Year Contract $500 voluntary ext.
Windbreaks	175%	225%	15 Year contract, $100 bonus
Wetlands	175%	200%	15 Year Contract, $500 voluntary ext.

After….


CONSERVATION BUFFERS…..
Farm "A"
Farm "B"
Transform the landscape on two adjoining farms

BUFFERS
Practices For Today's Agriculture!

MANURE MANAGEMENT and LIVESTOCK PROGRAMS in the SANDUSKY RIVER WATERSHED

Mark Fritz
SWCD
Manure Management

LIVESTOCK PRODUCTION 30 YEARS AGO

- Most farms had some livestock
- Relatively small numbers per farm
  - Dairy 50-70 cows
  - Swine 10 – 50 sows
  - Beef cattle 10 – 100 head
  - Sheep not uncommon
- Primarily solid (bedded) manure

HISTORY OF LIVESTOCK PROGRAMS

- SWCD / NRCS offers technical and design assistance for manure storages
- ODNR cost-share available in 1982
  1. Targeted to "problem" operations
  2. Limited $$$ available
  3. Not intended for widespread application
  4. Simple Manure Management Plan

HISTORY (cont.)

- MNM (Manure Nutrient Management) launched in 1996 by ODNR – DSW
  1. 25 counties / $500,000 +
  2. Crawford, Sandusky, Seneca and Wyandot SWCD's form joint program
  3. 5 year (declining) funding by ODNR

MNM Program Purpose

- Manage manure to protect the environment and enhance the producer's bottom line.
- Pro-active, voluntary and on-farm.

MNM Program Activities

- Manure Management Plans
- Using manure as fertilizer
  (Manure and soil testing, application rates)
- Conduit for new and applied technology
- Coordinate Cost-share
- Voluntary environmental audits
- Meetings, seminars, field days, test plots
- Respond to spills and complaints

CURRENT COST-SHARE PROGRAMS

- EQIP
- EPA 319 grants
- ODNR Pollution Abatement Fund

EQIP

- Environmental Quality Incentives Program
- USDA funded
- Administered by NRCS w/ assistance from SWCD's
- Annual allocations of up to $175,000 / county
- Cost-Share @ 50-75%
- Application / Ranking process
- Size of livestock operation not a factor
- Has provided access to smaller "problem" operations

EQIP PRACTICES

- Manure / Wastewater storages
- Facility runoff control
- Feedlot roofs
- Manure and Mortality composting facilities
- Tile water control structures
- Odor control windbreaks
- Grazing systems
- Comprehensive Nutrient Management Plans

EPA 319 GRANTS

- Targeted to smaller impaired subwatersheds
- Stream Habitat practices favored
- Emphasis on demonstrable progress toward use attainment

ODNR Pollution Abatement Funds

- Administered jointly by ODNR-DSW and local SWCD's
- Reduced funding of late
- Targeted to complaint situations with demonstrated pollution problem

CURRENT LIVESTOCK PRODUCTION in the SANDUSKY RIVER WATERSHED

- Fewer, larger farms
- Overall livestock numbers < 30 years ago
- Many more liquid manure systems
- Still a livestock-deficit area

LIVESTOCK GROWTH AREAS

- Contract swine finishing operations
  1. 1200 – 2400 head typical (1-2 barns)
  2. 200 – 400 acres required for P utilization
  3. Income opportunity for family farm
  4. Manure stored in under-floor concrete pit
  5. Contractor and/or lender typically requires a CNMP

LARGE (>700 HEAD) DAIRIES

- Dairy numbers still in decline
- Powerful economic incentives to either stay <100 cows or expand to >700
- Currently, 2-3 in planning stages
- Manure CAN be handled responsibly
- Joint ODA / EPA regulatory oversight, with technical assistance from NRCS / SWCD.

COW / CALF OPERATIONS

- Expansion in areas of watershed with less productive soils
- Fueled by:
  1. Good cattle prices
  2. Management Intensive Grazing practices
  3. EQIP cost-share

WATER QUALITY ISSUES ASSOCIATED WITH LIVESTOCK

In order of importance:

1. Nitrate loading to surface waters
2. Microbial pollution
3. Preferential Flow
4. Mis-managed manure applications on frozen or snow-covered ground

Non-Issues

1. P loading
2. Liquid earthen storages
3. Groundwater pollution (except Karst areas)

LIVESTOCK PRODUCTION IN THE FUTURE

- More smaller operations
  (grazing, direct marketing, ethnic, etc.)
- More CAFO's
- Transition AWAY from purely liquid, untreated systems
- Transition TO:
  1. Treated liquid systems
  2. Solid manure systems
  3. Combination systems

QUESTIONS ????

Ohio Department of Natural Resources
Division of Natural Areas and Preserves

Scenic Rivers Program

Scenic Rivers Program

Program Goal: To work cooperatively with local governments, businesses, landowners, non-profit organizations and other state and federal agencies to facilitate the protection of Ohio's remaining high quality stream systems

Scenic River Law, ORC Section 1517.16

Local community support

Scenic River Designation

Resolutions of support
Study team and designation study
Recommendation to the director
Intent to designate
Public comment period & hearings
Journal entry

Ohio's Scenic Rivers

First program in the nation, started in 1968

21 designated streams totaling 722 miles

Scenic River Watersheds drain about 13,611 square miles

Ohio's Scenic Rivers

DESIGNATIONS	RIVERS
Wild	Big & Little Darby Creeks
Scenic	Chagrin River
Recreational	Conneaut Creek
	Grand River
	Kokosing River
	Little Beaver Creek
	Little Miami River
	Maumee River
	Olentangy River
	Sandusky River
	Stillwater River
	Upper Cuyahoga

9 associated tributaries are also designated.

Little Beaver Creek State Wild and Scenic River

Big Darby Creek State and National Scenic River

Maumee State Scenic and Recreational River

Primary Protection Efforts

Protect riparian buffer and stream habitat

Reduce agricultural impacts

Stream Quality Monitoring Project

Reduce impacts of urbanization

Dam Removal

Benefits of Dam Removal

Safety Hazard – drowning hydraulics

Benefits of Dam Removal

Ecological

Negatively impact biological community

Riverine to lacustrine – loss of riffle, pool run complex

Lower species diversity, tolerant spp. predominant

Lower water quality, D.O.

Impede natural movement of bed load

Benefits of Dam Removal

Ecological

Excessive sedimentation - substrate embeddedness

Macroinvertebrates

Live in interstitial spaces – critical level in food chain

Unionid Mollusks

Sediment on gill surface causes decreased food filtering efficiency and asphyxiation

Simple Lithophils

- need a hard, clean, rocky substrate to lay eggs on - provide no parental care

Shorthead Redhorse
Moxostoma macrolepidotum

Benthic Insectivores

- need a hard, clean, rocky substrate – feed on macroinvertebrates

Hog Sucker
Hypentelium nigricans

Dam Removal
Sandusky State Scenic River

St. Johns Dam

Constructed 1935 by Ohio-American Water Company

Backup water supply for the city of Tiffin

Inspection in 1999 by ONDR, Division of Water determined the dam was unsafe

150 feet long, 7 feet high

Impounded 8.5 miles of Sandusky River

St. Johns Dam Research Project Partners

Macroinvertebrates – Heidelberg, Dr. Ken Krieger
ODNR, Division of Natural Areas and Preserves

Bivalve Unionids – OSU, Dr. Tom Watters

Fish – ODNR, Division of Wildlife, Natural Areas and Preserves

Geologic mapping of stream – ODNR, Division of Geological Survey, Lake Erie Group

Qualitative Habitat Evaluation Index (QHEI) - Ohio Department of Transportation

Additional independent research – OSU, Dr. Tim Granata

Sites monitored before – after removal – 5 yr. study

Dam Removal
St. Johns Dam Research

Monitoring sites above and below dam

Monitoring at Ohio Environmental Protection Agency reference sites

Detailed mapping was completed by the ODNR – Division of Geological Survey 9/22/03 to 11/4/03

Post dam removal mapping was performed in 7/26-27/04, 10/25/04, and 10/27-28/04

Macroinvertebrates

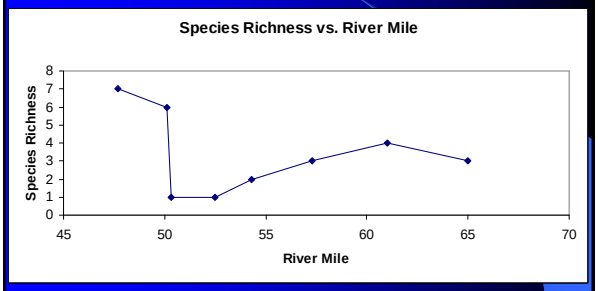
Utilized Hester-Dendy samplers per OEPA protocol

Monitoring 7 sites, some samplers lost in high water first year

St. Johns Research Results
Macroinvertebrates

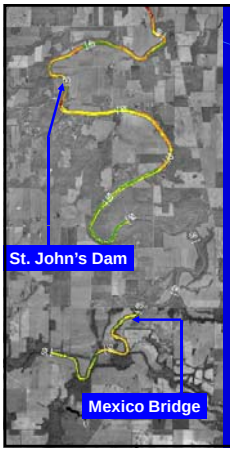
Species	Dam East 2003	Dam West 2003	Walnut Grove 2003	Dam East 2004	Dam West 2004	Walnut Grove 2004
Total # Taxa	12	12	13	25	18	20
Total # Individuals	39	104	41	2,800+	1,200+	452

St. Johns Research Results
Unionid Bi-valves



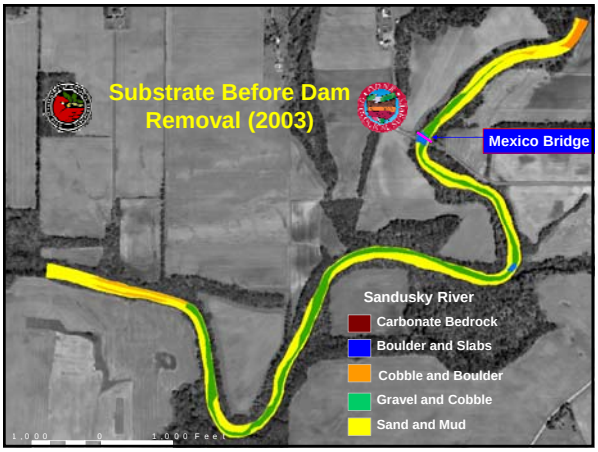
St. Johns Research Results
Captured Fish Species

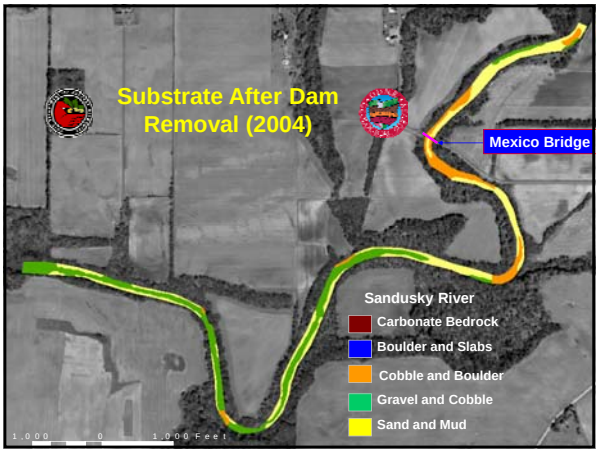
Species	Above Dam 2003	Walnut Grove 2003	Above Dam 2004	Walnut Grove 2004	Above Dam 2005	Walnut Grove 2005
Black Redhorse	0	0	5	0	8	3
Golden Redhorse	3	6	0	1	4	67
Greater Redhorse (T)	0	0	0	0	0	7
River Redhorse (I)	0	0	0	0	0	2
Common Carp	9	16	0	0	0	20
Smallmouth Bass	1	0	8	0	1	1
Green Sunfish	19	7	6	4	2	3

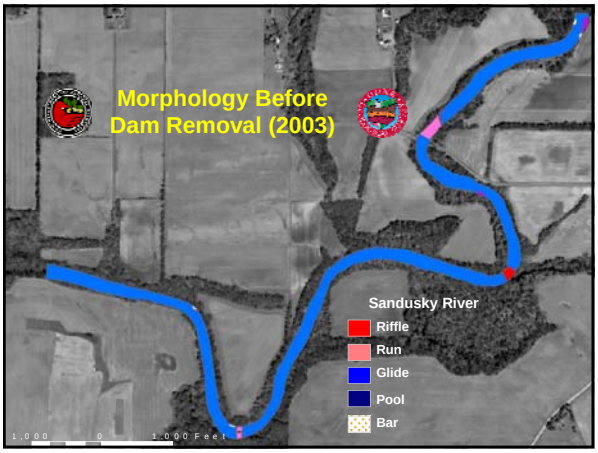


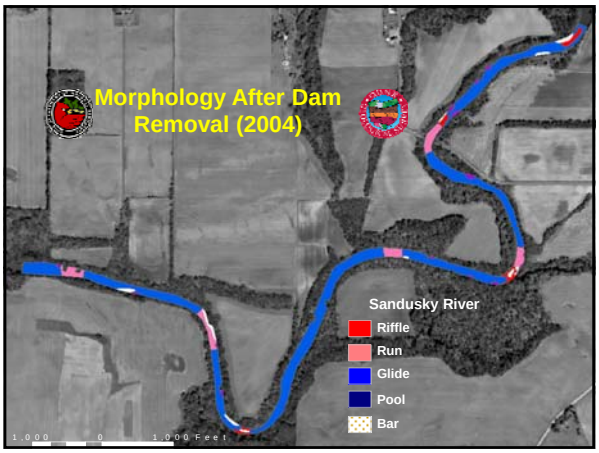
Mexico Bridge Reach:

Substrate, morphology, and river's edge was mapped in the Summer and Fall of 2004 for comparison to mapping before the St. John's Dam removal in 2003

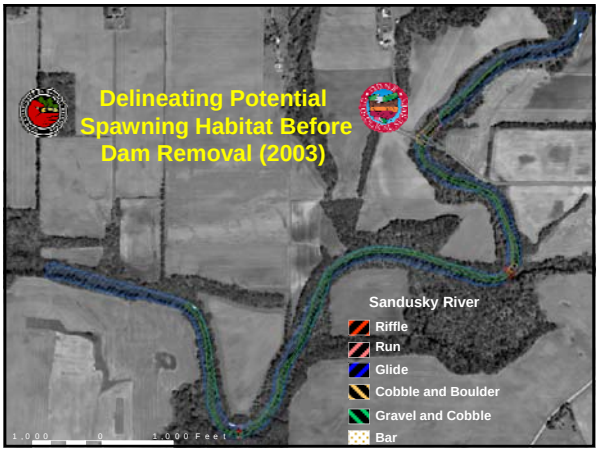


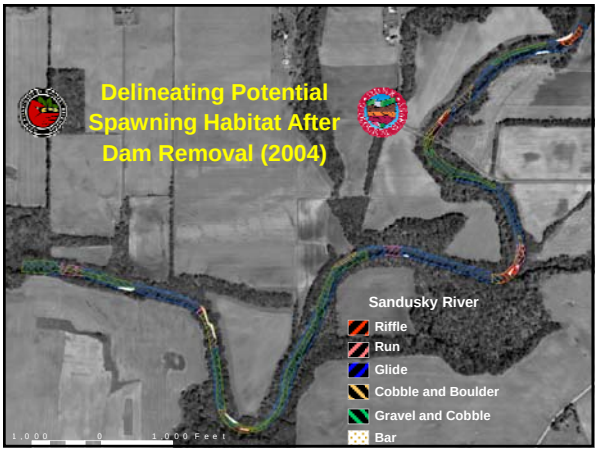


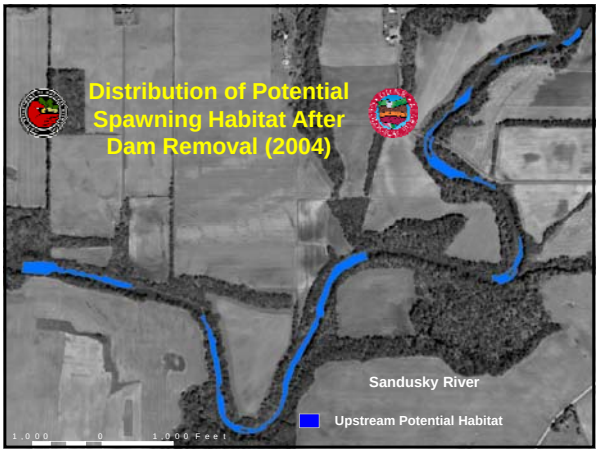


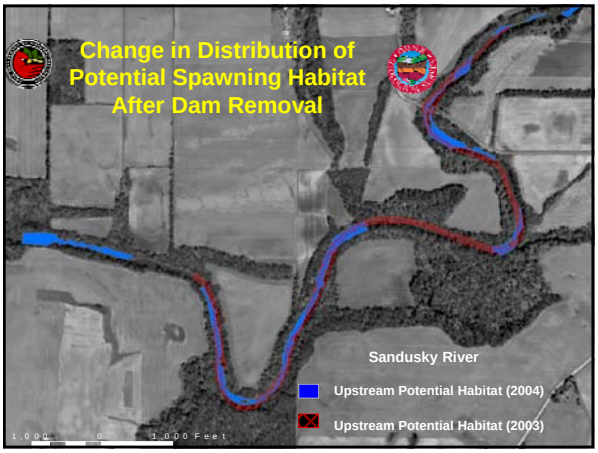

Morphology After Dam Removal (2004)
Sandusky River
Riffle
Run
Glide
Pool
Bar
1,000 0 1,000 Feet

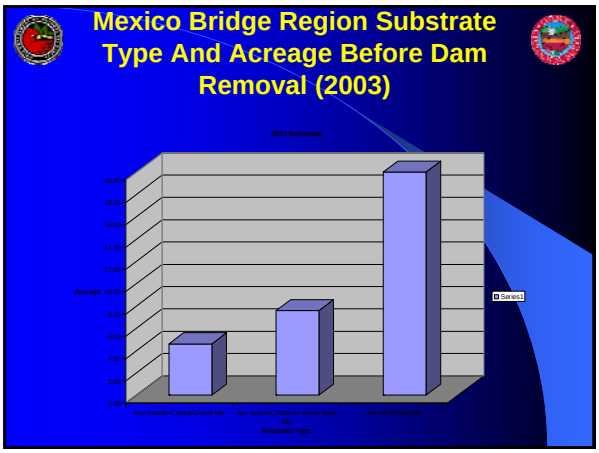
Potential Spawning Habitat Upstream of Mexico Bridge, Sandusky River


Delineating Potential Spawning Habitat Before Dam Removal (2003)
Sandusky River
Riffle
Run
Glide
Cobble and Boulder
Gravel and Cobble
Bar
1,000 0 1,000 Feet


Delineating Potential Spawning Habitat After Dam Removal (2004)
Sandusky River
Riffle
Run
Glide
Cobble and Boulder
Gravel and Cobble
Bar
1,000 0 1,000 Feet


Distribution of Potential Spawning Habitat After Dam Removal (2004)
Sandusky River
Upstream Potential Habitat
1,000 0 1,000 Feet


Change in Distribution of Potential Spawning Habitat After Dam Removal
Sandusky River
Upstream Potential Habitat (2004)
Upstream Potential Habitat (2003)
1,000 0 1,000 Feet



Thank You for Your Support

The Purpose, Design and Benefits of Two Stage and Over Wide Ditches

Jessica D'Ambrosio and Jon Witter

Ohio State University

Dan Mecklenburg
ODNR

Andy Ward, Erick Powell
Ohio State University

Ohio Headwater Streams

- Facilitate Agricultural Drainage
- Low Gradient
- Deepened and Straightened
- Routinely Maintained

Quick Facts

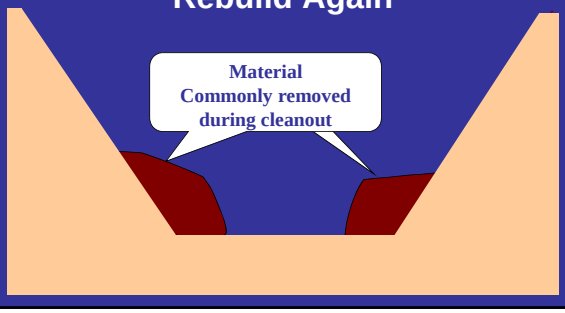
- 60,000 miles of streams in Ohio
- 22,500 miles considered drainage ditches
- 4,000 miles under some form of maintenance (Sanders, 2000)

A Recently Maintained Channel

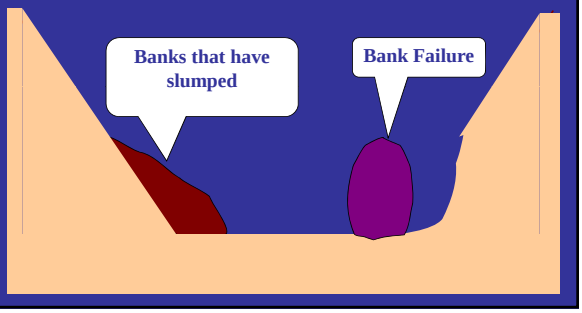
A Two Stage Channel

A Constructed Two Stage Channel

Maintenance Often Removes Fluvial Benches That Will Rebuild Again



Features due to Bank Failure are not Fluvial Benches



Bank Failure in an Illinois Ditch

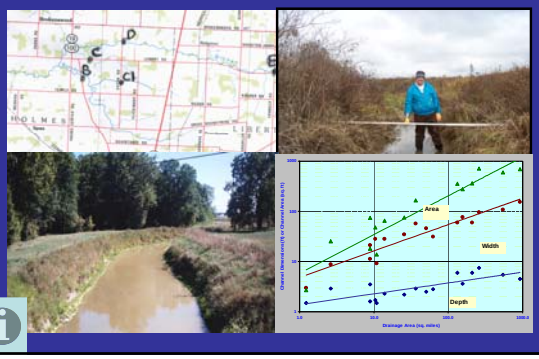
Streams and ditches

- Striking similarities between streams and ditches
  - Fluvial Geomorphology
    - Fluvial – produced by action of a river or stream
    - Geomorphology – “earth” “change” “knowledge”
  - Streams and ditches are predictable

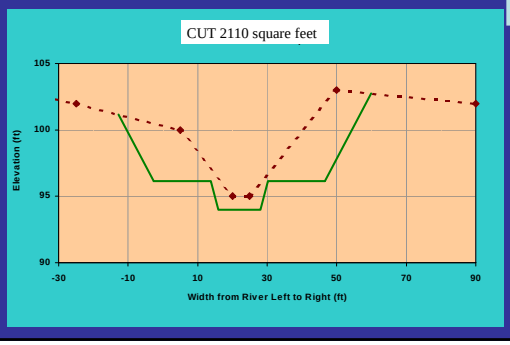
Rapid Survey

Use A Tape And Rod

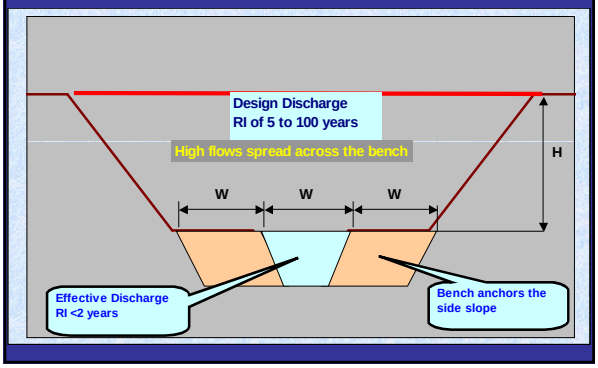
A Rapid Regional Curve Assessment Method



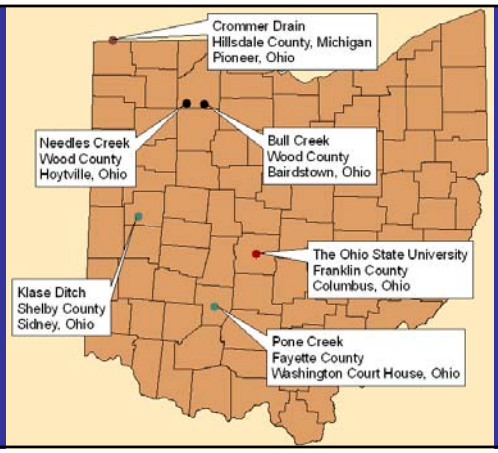
ODNR Ditch Design Spreadsheet



Bench Characteristics

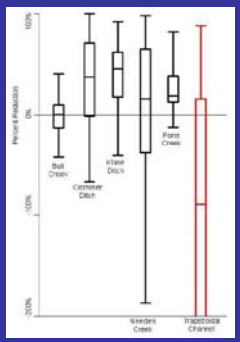


Does implementing the two-stage channel concept in agricultural headwater streams result in water quality benefits?



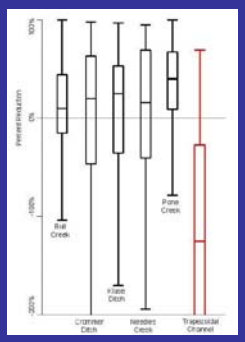
Nitrate Load Percent Reduction

Site	Median Value
Bull Creek	1%
Crommer Drain	37%
Klase Ditch	45%
Needles Creek	16%
Pone Creek	20%
Trapezoidal	-86%



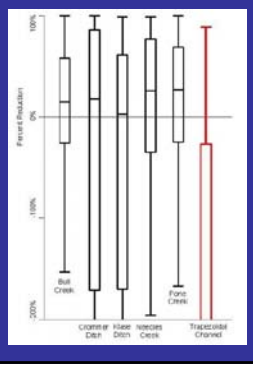
Total Phosphorus Load Percent Reduction

Site	Median Value
Bull Creek	10%
Crommer Drain	20%
Klase Ditch	26%
Needles Creek	16%
Pone Creek	40%
Trapezoidal	-130%

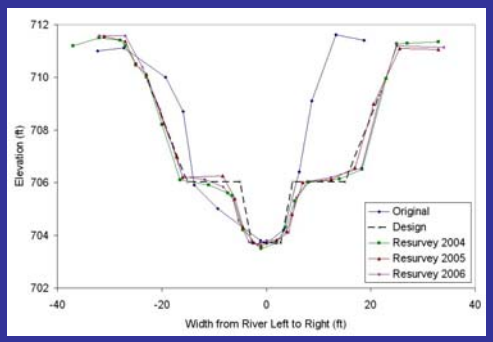


Suspended Solids Load Percent Reduction

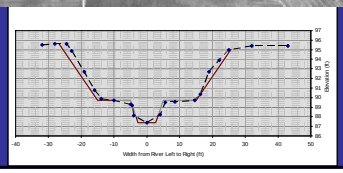
Site	Median Value
Bull Creek	15%
Crommer Drain	18%
Klase Ditch	3%
Needles Creek	25%
Pone Creek	27%
Trapezoidal	-230%



Channel Cross Section Measurements



Thorn Run RM 5.2



Thorn Run RM 5.2

Site: Thorn Run RM 5.2	
Fish Species	**Number**
Creek Chub	18
Rainbow Darter	67
Central Stoneroller	5
Hognose Sucker	2
Johnny Darter	28
Bluntnose Minnow	2
Fantail Darter	1
Pumpkin Seed	1

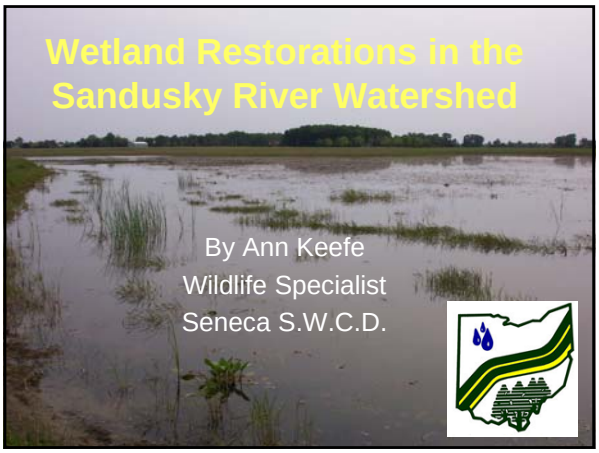
Rainbow Darter

Summary

- Two-stage channels, based on geomorphic principles, are an alternative channel design to traditional trapezoidal channels
- Two-stage channels could be a 'best management practice' for agricultural drainage channels
- Of the sampled sites, the two-stage channels had better water quality performance than the trapezoidal channel
- Two-stage ditch construction has demonstrated benefits both for drainage and in-stream habitat. In addition to improved substrate habitat, cover improves and summer temperatures decrease.

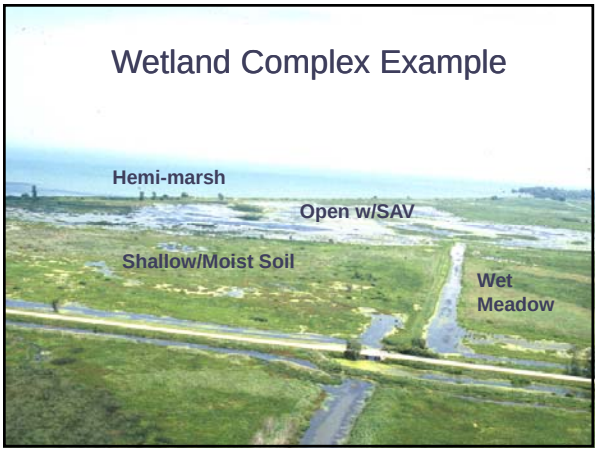
Tradeoffs

- Potential Disadvantages
  - Loss of farmable land
  - Increased initial costs
- Potential Benefits
  - Improved water quality, ecological function
  - Potential long-term reduction of maintenance costs
  - Improved drainage capacity


Wetland Restorations in the Sandusky River Watershed
By Ann Keefe
Wildlife Specialist
Seneca S.W.C.D.

Habitat for Healthy Water
Improving Water Quality in Ohio's Critical Coastal Area through Wetland Restoration
Heather Braun and Ann Keefe
Ducks Unlimited, Inc.

Classes of Freshwater Marshes
Hydric Soil
Hydric Vegetation
Presence of Water
Shallow hemi-marsh
Open water marsh
Wet Meadow
moist soil
Deep water marsh
Shrub-scrub


Wetland Complex Example
Hemi-marsh
Open w/SAV
Shallow/Moist Soil
Wet Meadow

Wetland Loss
> 90%

Wetlands & Water Quality:
NPS Pollution is a Big Concern

Sandusky Bay
Causes of Nonpoint Source Impairment

- Organic enrichment
- Dissolved oxygen
- Habitat alteration
- Flow alteration
- Siltation

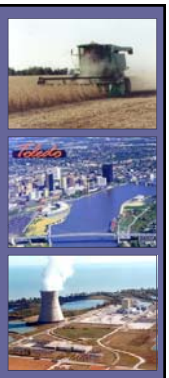
235-700 metric tons of sediment annually

Office of Coastal Management:

- Coordinate Ohio's Coastal Nonpoint Pollution Control Program

Slide provided by ODNR Coastal Management Program, 2003)

Habitat Alteration

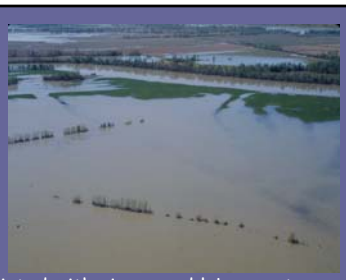


Intensive Agriculture and Urban Sprawl Result in major wetland losses

Wetland Benefits

- **Wildlife habitat**
- **Groundwater recharge**
- **Flood storage**
- **Water quality**
  - **often overlooked !!**

Flood Protection



- Wetlands associated with rivers and lakes capture and retain water, reducing the *duration* and *severity* of foods.
- Inland wetlands intercept surface flow and slow it down, reducing the *potential* for floods and minimizing drought.

Sandusky County Wetland outlets to Karst sinkhole

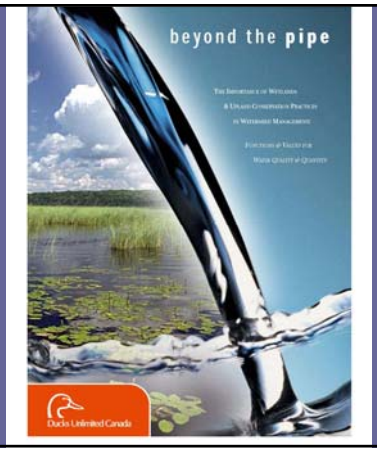
Wetland Water Quality Benefit

- DNAP stream monitoring
- seine Raccoon Creek
- seine adjacent wetland
- You compare!!!

Biological Activity Tremendous in Wetlands compared to adjacent impacted stream

Wetland Benefits - Water Quality

- **Nutrient and sediment sinks**
  - **80% removal of nitrates**
  - **92% removal of phosphorous**
  - **Sediment reduction linked to hydrology**
- **90% reduction of coliform bacteria**
- **Pesticide reduction**



Grassland Benefits

- **Nesting cover for wildlife**
- **Restore native ecosystem**
  - **Absorb 7 1/2 inches of rain per hour**
- **Water quality**
  - **>75% removal of sediment**
  - **67-96% reduction in nitrogen**
  - **27-97% reduction phosphorous**
  - **74% reduction of fecal coliform**
  - **8-100% reduction pesticides**

Wetlands Programs…..

NAWCA
Habitat For Healthy Water
ODNR DOW
WHIP
CREP
CRP
WRP
USFWS
CCRP

Habitat For Healthy Water Program

- Ducks Unlimited
- Erie SWCD
- Green Creek Hunt Club
- Ohio EPA
- ODNR-Div. Of Wildlife
- ODNR-Div. Of Soil & Water
- Ottawa SWCD
- Sandusky NRCS
- Sandusky River Watershed Coalition
- Sandusky SWCD
- Seneca SWCD
- Winous Point Marsh Conservancy

The basics of wetland funding…

- All programs provide cost-share-50% or greater
- Some provide annual rental payments for short-term (i.e. 10-30 years), rates determined by soil productivity and by which program you choose (paid more for longer years)
- Some programs provide one time bonuses (i.e. CREP pays $500 one time bonus)
- Or, some provide lump sum payments for long term easements on deeds (up to $2500 per acre one time for WRP)

Project Eligibility and Evaluation

- Location
  - Ohio Coastal Zone?
  - Impaired Streams?
  - Karst Region?
- > 50% hydric soils?
- Land use and site characteristics
- Tile in area?
- Size
- Proximity to conservation lands
- Proximity to other BMPs
- Length of contract

Wetland Restoration

- Survey and design
- Permits—Army Corps, EPA, NEPA, SHIPO
- Construction management
- Management plan

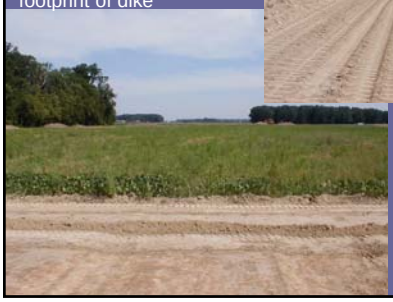
Basic Restoration Techniques

CREP Wetland

Seneca County

July 11, 2005

Remove topsoil under footprint of dike



Leave all other hydric soil areas as undisturbed as possible

July 2005 Build dike with pan

Long process to compact 6" at time

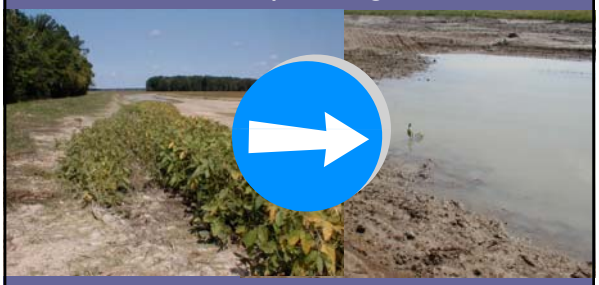
Remember to keep toe clear

Allows gentle slope 3:1 or greater→ more natural transition, limits seepage

Wetland Sept 2005

Dikes are seeded in August, and begin to green up by September. Water begins to pool in borrow areas.

Sept 2005
first wetland plants germinate



Crop field begins to flood and wetland plants start to replace the soybeans.

April 19, 2006 wetland fills with spring rains & wildlife moved in…

Shorebirds, teal, mallards, geese, numerous amphibians, wetland plants

Good buffers make good wetlands!

Muddy Creek Wetland before and after

Lake Erie Wetland Restoration Erie County

BEFORE

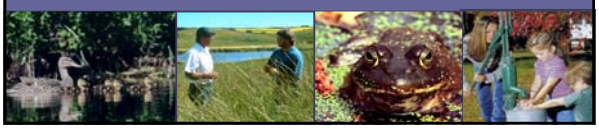
AFTER

Close-up of Erie County Wetland Construction

Pickerel Creek Wetland

Conclusions and Recommendations

- Landowners want programs that restore wetlands
- Wetlands are an overlooked component of approach to watershed health
- More research and monitoring to determine relative effectiveness of wetlands
- Partnerships are the key to accomplishing common goals



CONSERVATION ACTION PROJECT

Improving Water Quality Through
Increased Conservation Tillage Acres

ACTIVITIES

- Collecting Demonstration Plot Data
- Soil Doctor Precision Applicator – nitrate reduction
- Deep Tillage – removing dense layers
- Strip Tillage – clearing residue from row to be seeded
- Residue Management – keeping dense layers from recurring
- Cover Crop – reducing soil loss, improving soil structure

SCOPE

81 NW Ohio Farms in Defiance, Fulton, Henry, Lucas, Paulding, Williams, Wood Counties border or drain into Maumee River and Lake Erie

SITUATION – MAUMEE RIVER

- 3% of Lake Erie Drainage Area
- 37% of Sedimentation into Lake Erie
- 80% of sedimentation comes from farmland
- 80% of land is in row crop corn & soybeans

PROBLEM

- 1.25# phosphorus loss per acre
- 1,850,000 Acres of Cropland
- 2,312,500# Phosphorus To Western Lake Erie Annually

CONSERVATION TILLAGE

'Any tillage system leaving 30% year round reside cover'

30% cover = 50% soil loss reduction

50-60% cover = 80-90% soil loss reduction

MAJOR SOIL MANAGEMENT PROBLEMS

- Reducing and eliminating soil compaction
- Managing increased residue from higher yields
- Keeping compaction from recurring

SOIL PENETROMETER MEASUREMENTS

- Most fields showed - 1" Dense Layer
- At 4" – use of disk, spring tool, field cultivator
- At 6-9" – chisel plow
- At 9-12" – moldboard plow
- At 15-18" & 24-28" – heavy equipment on wet soils??

TOOLS & EQUIPMENT DEMONSTRATED

AerWay, Blue Jet, DMI Nutriplacr, Dyna Master/Dyna Drive, JD 550 Mulch Master, Krouse Land Saver, McFarland Paratil, Phillips Rotary Harrow, Phoenix Rotary Harrow, Progressive Remlinger, Soil Doctor Prescription Applicator and To The Max

BASIC AIM OF PLOT WORK

Choosing best management practice on basis of yield data

WEAKEST FARM PLOT FEATURE

Producing quality yield data

HOW BAD WAS IT?

- Only 5 out of 25 plots produced data where cause could be identified
- Something other than the practice, caused the yield difference
- First year harvest – super results
- Just what we expected & wanted to happen
- Second & third year - the same plan
- No consistency with first year data

HISTORY OF ADOPTING A NEW IDEA

- Rubber tires – 40 years
- Hybrid seed – 40 years
- Farm tractors – 50 years
- Conservation tillage – 60 years and still running

WAYS TO MESS UP YIELD DATA & DETER ADOPTION

- Forget to put something in gear (Second pass across field can reduce tillage benefit by 50%)
- Run treatments with tile lines (Tough, if drainage is with the natural way of planting field)
- Change practices within plot (Varieties, fertilizer, weed, insect or disease control) (Adds another practice in plot)
- Plant or Harvest on different days (Rain or Moisture delays)

Continued…

- Choose field with several soil types
- Choose field where nutrition varies Pick worst field on farm
- Treatment has slim chance of success
- Pick best field on farm
- Little chance of yield difference from the control treatment (no stress)

WAYS TO REMEDY ERRORS

- **Scout fields**
- Check plot layout & design
- Collect weather/rain data
- Discover any operator omission and commission
- Geo reference fields to locate, identify problem areas (IPAQ Handheld - accurate to 3 feet - one step)

Use Randomized, Replicated Plot System

Three Practices

Border	A practice	B practice	C practice	B practice	A practice	C practice	C practice	B practice	A practice	A practice	C practice	B practice	Border

Two Practices

ATRIAL	BTRIAl	BTRIAl	ATRIAL	ATRIAL	BTRIAl	BTRIAl	ATRIAL

All treatments exposed evenly across field takes more time, but is essential for accurate data.

RULE OF THUMB

- Optimum plot size is .1-.3 acre)
- Minimum farm field size is 10 acres

Count Corn Emergence

- Corn plant emerging 72 hours late will abort
- Make compaction tests in June
- Follow plant growth during the summer
- Check weed, insect & disease pressure
- Draw soil samples same time each year - August
- Count stalks with harvestable ears

Follow Up of Emergence Check

- Take ear leaf samples for nutrient level tests
- Collect harvest data with yield monitor & global positioning
- Analyze data to determine cause of yield change

NEW TECHNOLOGY CAN

- Gather data every 6-7 foot forward travel
- Pinpoint problem areas
- Remove problem areas from yield data
- Get 20 good plot results from 25 trials

BENEFITS OF COVER CROPS

- 6" to dense layer becomes 7" in one year
- Better control of weeds, soil loss, moisture
- Can travel on ground with equipment
- Increase yields
- Keep nitrogen out of water supply
- Reduce wind and water erosion
- Increase root mass

Current & Proposed USDA Funding Programs for Landowners in the Sandusky Watershed

Todd Brace, Conservation Chief
Ohio FSA State Office
Sandusky River Watershed Symposium
June 2006

USDA

USDA Conservation Programming: 1930's to Present

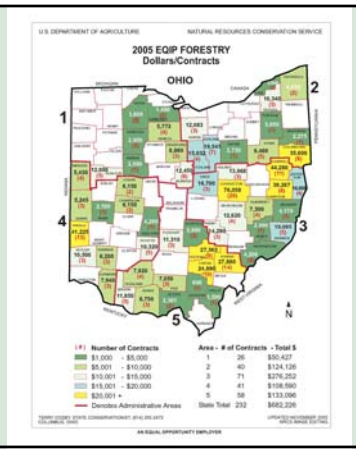
1950's to 1984
- Soil Bank (FSA)
  (1985 Farm Bill)
  CRP (FSA)

1930's to 1995
- ACP (FSA)
  (1995 Farm Bill)
  EQIP (NRCS)
  WHIP (NRCS)
  WRP (NRCS)

2002
- CSP (NRCS)
  (2002 Farm Bill)
  CSP (NRCS)

USDA

Environmental Quality Incentive Program (EQIP)



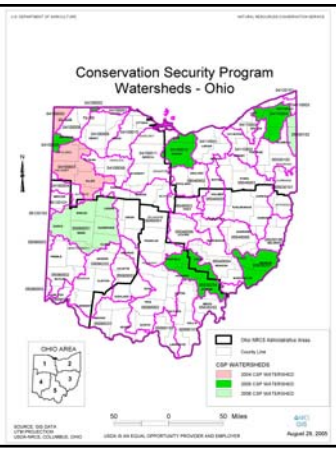
2006 EQIP Program

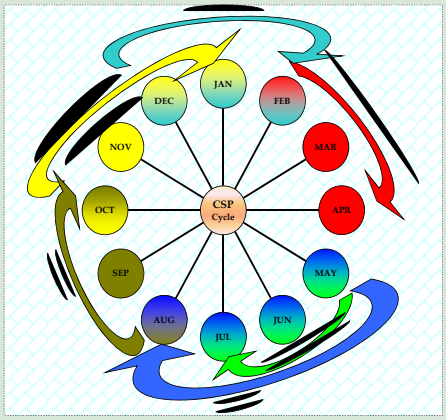
- $12,740,813 scheduled for allocation to all 88 counties
- Additional 1+ million given to Ohio from NRCS National Office
- 1,400 estimated contracts will be developed by NRCS field offices in 2006
- Special project with ODNR - Division of Forestry again in 2006

USDA

Eligible Conservation Practices

- Composting Facility (317)
- Fence (382)
- Grade Stabilization Structure (410)
- Manure Transfer (634)
- Pipeline (516)
- Structure for Water Control (587)
- Underground Outlet (620)
- Waste Storage System (312), Waste Storage Facility (313)
- Wastewater and Feedlot Runoff Control System (784)
- Waste Treatment Lagoon (359)
- Heavy Use Area Protection (561)





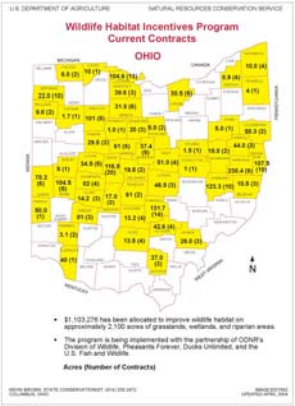
CSP in Ohio – 2004/2005

2004			
Total Applications	Applications Approved	Acres	Dollars
265	**241**	**122,408**	**$24,786,299**

2005			
Total Applications	Applications Approved	Acres	Dollars
509	**451**	**234,930**	**$36,732,141**

2006 Wetland Reserve Program

- $3,212,654 scheduled for allocation
- Plus an additional $477,000 recently allocated from NRCS National Office
- Change in 2006 → $2,000 per acre CAP value no longer being used



2006 Wildlife Habitat Incentive Program

- $314,381 scheduled to be allocated to NRCS field offices
- ODNR - Division of Wildlife is being asked to assist NRCS field offices with application process

Conservation Reserve Program (CRP)

- Federal government's largest environmental conservation program
- Established in 1985
- Currently 326,000 acres enrolled in Ohio (36 million nationally)
- ***Voluntary enrollment***

Conservation Reserve Program

2 Types of CRP Signups:

Continuous Signup (non-competitive)

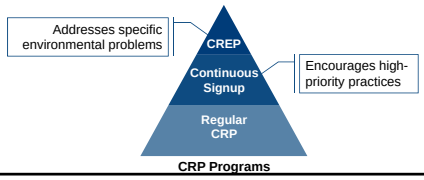
- Small high benefit practices such as grass filter strips, waterways, etc.

General Signup (competitive)

- Specific signup period held
- Usually whole fields or farms enrolled

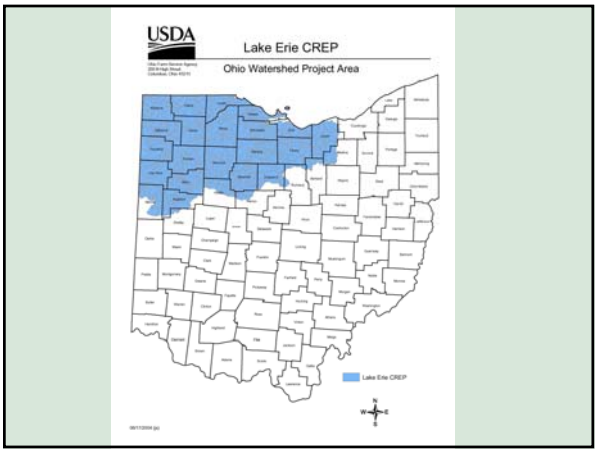
Enhancing CRP

- **General CRP Signup**
- **Continuous Signup CRP**
  - Encourage high priority practices
- **Conservation Reserve Enhancement Program (CREP)**
  - Addresses specific environmental problems
  - Partners CRP with state or local programs



Lake Erie Conservation Reserve Program (CREP)

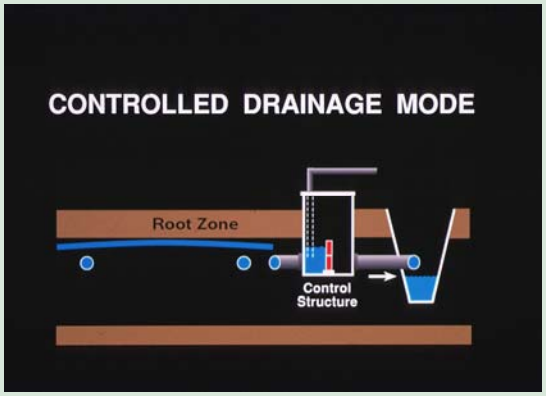
- $201 million project (Partnership USDA/State of Ohio)
- Twenty-seven counties in north and northwest Ohio are eligible
- Approximately 25,000 of 67,000 acres currently enrolled

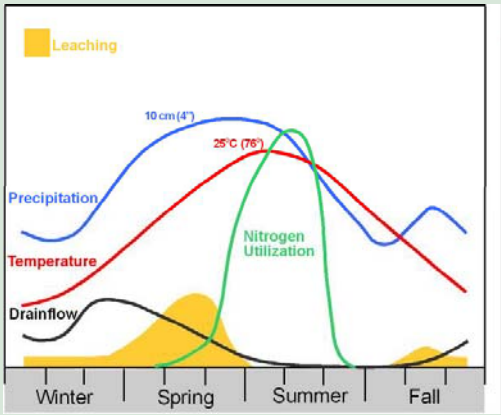


Lake Erie CREP Practice Summary Table

Practice	Incentive Payments (% of SRR)	Cost Share %	SIP	PIP	State of Ohio 30 Year Contract Extensions	State of Ohio $100/ac. Tree Planting Bonus	Div. of Wildlife Warm Season Grass and Wetlands Incentive
CP1●	55	50					√
CP2●	75	50					√
CP3A▲	125	50			√	√	
CP4D▲	75	50					√
CP5A	125	50	√	√		√	
CP21 (CSG) ▲	55	50	√	√			
CP21 (WSG) ▲	75	50	√	√			√
CP22▲	125	50	√	√	√	√	√
CP23	100	50	Incentive = 25% of Hydrology Restoration		√		√
CP23A	100	50	Incentive = 25% of Hydrology Restoration		√		√
CP25■	125	50			√	√	√

Practice	*CP21 Grass Filter Strip*	CP21 Grass Filter Strip	CP21 WSG Filter Strip	*CP22 Riparian Forest Buffer*	CP22 Riparian Forest Buffer
Contract length	*20*	15	15	*30*	30
Soil Rental Rate	*155%*	155%	175%	*175%*	225%
State Bonus	*$200*	none	$20 (DOW)	*$500*	$600
SIP	*$140*	$140	$140	*$140*	$140
Annual Rental Payment/Ac.	*$161*	$161	$182	*$182*	$234
Total Dollars Per Contract	*$2,755*	$2,555	$2,890	*$3,370*	$4,250
Average Annual Payment over contract period	*$138*	$170	$193	*$112*	$142





Controlled Drainage: Implications

- **water management**
- **hydrology**
- **water quality**

Active CRP/CREP in the Sandusky River Watershed

- ~ 50,000 acres enrolled in CRP
- ~ 5,000 acres enrolled in Lake Erie CREP

General CRP Signup #??

Signup Period ??

EBI Ranking Factors

EBI Point Factors that determine eligibility:

- → Wildlife
- → Water Quality
- → Erosion
- → Enduring Benefits
- → Air Quality
- → Cost

General Signup Eligibility

Land Eligibility:

- Must have been cropped to an ag commodity 4 of 6 years between 1996 - 2001
- Must be legally and physically capable of producing an ag commodity

General Signup Eligibility

Land Ownership Eligibility:

- Must have been owned for at least 12 months

Buffer Strips stop soil erosion from reaching streams!

Partners for Fish and Wildlife

OHIO

PARTNERS FOR FISH & WILDLIFE PROGRAM

KURT WATERSTRADT – STATE COORDINATOR

Mission Statement

The mission of the U.S. Fish and Wildlife Service is, by working with others, to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people.

The Service's Partners for Fish and Wildlife program helps accomplish this mission by offering technical and financial assistance to private (non-federal) landowners to voluntarily restore wetlands and other fish and wildlife habitats on their land.

Restoration Projects

- Restoring wetland hydrology by plugging drainage ditches, breaking tile drainage systems, installing water control structures, dike construction & re-establishing old connections with waterways
- Planting native trees & shrubs in formerly forested wetlands & other habitats
- Planting native grasslands & other vegetation
- Installing fencing & off-stream livestock watering facilities to allow for restoration of stream and riparian areas
- Removal of exotic plants & animals which compete with native fish & wildlife & alter their natural habitats.
- Prescribed burning as a method of removing exotic species & to restore natural disturbance regimes necessary for some species survival.
- Reconstruction of in-stream aquatic habitat through bioengineering techniques.

Program Summary

- **Results-oriented habitat program**
  → Get the funding on the ground
- **Can fund a project 100%**
  → 50% cost-share nationally
- **Build relationships with landowners**
  → Follow through on projects, monitor
- **Conservation partners are key to success**
  → Leverage funding to put more habitat on the ground

Restoring Ohio's Waters

Ohio's Section 319 Grants Program

Ohio Environmental Protection Agency
Division of Surface Water

Ohio's Clean Water Goal

To successfully achieve aquatic life use attainment in 80% of Ohio's waters by 2010.

Division of Surface Water
Programs & Practices

The Division of Surface Water implements several different approaches to help reach our Clean Water goals including:

- Permitting & Regulatory
- Ecological Assessment & Monitoring
- TMDL and Watershed Planning
- Nonpoint Source Management
- Section 319 Grants

Section 319 Program Goals & Purpose

The Section 319 program provides grant funding for projects that eliminate or reduce water quality impairments caused by nonpoint sources of pollution.

What Prompted Our Review of the Program?

- Need to align 319 projects with water quality goals.
- Growing national emphasis on measuring environmental benefits.
- Need to focus limited funding on projects that produce MEASUREABLE environmental results.

Looking Back to Move Forward
Effectiveness of Past Practices

Past Funding

Results

Who Received Grants & What Did they Do with the $$$

Problems Identified

Section 319 Implementation Funding

FFY2001 – FFY2005 Total 319 Funds Awarded		$20,855,886
FFY2001	30 Grants	$3,977,508
FFY2002	17 Grants	$4,185,839
FFY2003	8 Grants	$4,129,563
FFY2004	17 Grants	$4,949,940
FFY2005	23 Grants	$3,613,036

Funding by Project Type FFY2001 – FFY 2005

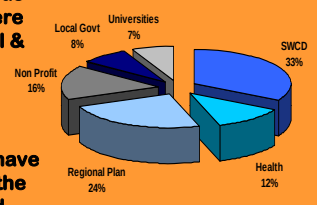
	2001-2005
Home Septic Projects	27%
AML Reclamation	26%
Agricultural BMPs	16%
Stream Restoration	8%
Dam Removal	8%
Watershed Planning	4%

Funding by Watershed FFY01-FFY05

1. Raccoon Creek	$2,250,000
2. Sunday Creek	$1,915,392
3. SANDUSKY	$1,880,000
4. Cuyahoga River	$1,343,750
5. Stillwater River	$1,220,478

Past Funding Practices FFY2001 - FFY2005

- 45% of 319 grant funds during the period were awarded to local Soil & Water Conservation Districts and Health Departments.
- Local governments have received only 8% of the grant funds awarded during the period.



Identified Problems

- Program & Resource Misalignment
  - Disproportionate funding on NPS prevention
- Disappointing Performance
  - Certain types of projects were not delivering promised benefits.
- Need for more Timely Oversight
  - Enhanced oversight needed when local projects stall.
- Output-based Management System
  - Management systems were tracking outputs rather than outcomes.

Revised 319 Funding Hierarchy

Previous criteria focused primarily on eligibility rather than desired project results.

DESIRED RESULTS		PRIORITY ELIGIBILITY
	Highest	
Eliminate Impairments		Watersheds with TMDLs
Restore Impaired Waters		Endorsed Watershed Plan
Reduce Pollutants		Conditionally Endorsed Plan
Pollution Prevention		Watershed Coordinator
Planning or Research		No Watershed Coordinator
	Lowest	

USEPA NPS Program Measures

- Measure "W"—eliminate at least one NPS impairment in 200 streams nationwide by 2012 … in Ohio, this means at least six streams … we're shooting for 20!!!
- Number of watershed plans and TMDLs "substantially implemented" … in Ohio, this number is very low and must improve quickly!!!!

319 Grant Funding by Project Type FFY 2006

	2001-05	2006
Home Septic Projects	27%	0%
AML Reclamation	26%	0%
Agricultural BMPs	16%	18%
Stream Restoration	8%	49%
Dam Removal	8%	32%
Watershed Planning	4%	$400K+

Stream Restoration

Dam Removals

Agricultural BMP Projects

Riparian Restoration

Wetland Restoration Projects

319 funded projects resulted in a net gain of 116 acres of wetlands during 2005

Conservation Easements

Protecting the Best

Watershed Planning Projects

•Ohio EPA continues to strongly support local watershed planning with more than $3 million awarded since 2000.

•However, watershed groups are needing to make a **VERY IMPORTANT** transition– **moving** from planning to meaningful implementation.

Watershed Plans & 319 Grants

Ohio's section 319(h) grants program rewards watersheds with endorsed plans and TMDLs with substantial extra credit during grant review for projects culled from endorsed plans.

Keys to Successful Projects

- Recent USEPA research identified that the following ingredients were valuable in helping to insure successful water quality projects:
  - A Watershed Plan (or TMDL) that is FOCUSED and achievable … targeting activity on those who are making disproportionate contributions to the pollutant load!
  - DIVERSITY of approaches …
  - Committed LOCAL GOVERNMENT partners …
  - Active involvement of BROAD-BASED stakeholders, including citizens

Kent Dam Removal 319 Project

Before Restoration of Flow

Fish community was poor and not meeting WWH standards IBI=28 (WWH IBI>40).

Habitat scores were not meeting WWH standards (QHEI=51)

Kent Dam Removal 319 Project
Following Restoration of Flow

Kent Dam Removal 319 Project
Measurable Improvements

- Fish Scores (IBI) Increased 57% to FULL Attainment of WWH
- Habitat (QHEI) Increased 56% to FULL Attainment of WWH

Powderlick Run 319 Restoration Project
Before Restoration

Powderlick Run 319 Restoration Project
Following Restoration

Natural sinuosity, floodplain and flow restored.

Project demonstrates sound scientific methods for restoring biology and water quality.

Powderlick Run 319 Restoration Project
Environmental Results

Metric	Prior Condition 1999-MWH	Post Condition 2003	Post Condition 2005	WWH GOAL
QHEI Habitat	39	58	58	60
IBI	18	30	34	40

What Does the Future Hold???

Ohio's Revised Nonpoint Source Management Plan

TRAX
tracking excellence

Information Management

Standardized Monitoring Protocol

One QAPP fits ALL

Outcome Based Contracting

Special Project Grants

In 2007 we will be issuing a supplemental RFP to fund smaller projects with reprogrammed and unspent 319 funds.

Customer Service

We are developing a culture of customer service!!!

Restructuring Program

Adding Grant Management Staff

Dramatically Streamlining Reporting

Improved Consistency & Timeliness

Ohio's Section 319 Program Culture of Excellence

1. **Emphasize ACTIVE restoration**
2. **Build upon SUCCESS**
3. **Improved ACCOUNTABILITY**
4. **Focus on OUTCOMES**

Section 319 Grants Program
ACTIVELY Improving Ohio's Waters

THE END

Watershed Planning and Current Implementation Programs in the Sandusky River Watershed

Chris Riddle
Watershed Coordinator
Sandusky River Watershed Coalition
www.sanduskyriver.org

Sandusky River Watershed Coalition

- Organized in 1997
- Provide leadership for the conservation and enhancement of the Sandusky River watershed and its natural resources through community-based planning, education, and action

www.sanduskyriver.org

Watershed Planning – Setting The Stage for Success

Watershed Planning Gets Started

- Resource Inventory and Management Plan – 2001
- Focus on entire 8-digit HUC
- Then…Appendix 8

TMDL For Upper Sandusky Watershed

Subwatershed Planning

- Development on 11-digit HUC level
- 14 watershed plans need completed
- 2004, Lake Erie Protection Fund supports Water Quality Laboratory to start planning.
- Honey Creek and Broken Sword Creek

The Setbacks

- Honey Creek is drafted…grant dollars run out.
- Broken Sword Creek is in the earliest stages of development.
- Coastal Management Assistance Grant funds development of plan for Sandusky River – Tiffin, making it a priority, and leaving BS WAP out in the cold.

Mixed Success

- 2 years later… Honey Creek WAP is first Watershed Action Plan in Ohio's Lake Erie Basin to receive Full Endorsement Status (04/27/06).
- Broken Sword Creek is being drafted, after a year on the back burner.
- Sandusky River – Tiffin is headed to public comment in July, in an attempt to stay on or close to schedule.

Ballville Dam – Fall 2004

Future of Planning

- Broken Sword Creek will be completed, just a matter of when – hopefully fall '06.
- Sandusky River – Tiffin will be completed by late fall 2006.
- 11 more plans need written, at an estimated cost of $30,000 - $40,000 each.
- 3-year review cycle for completed plans.

Implementation – Putting the Plans to Work

Coordinator Grant, Watershed Coordinator Grant Program, 2000

- Funding for 6 years of a watershed coordinator.
- Declining funds to push local sponsorship.
- Results:

Applied for 3 year continued funding in 2006.

Produced 1-3 WAP's and $2million in grant dollars.

Agricultural Practices, EPA Section 319 Grant, 2002

- Provided cost share on a variety of agricultural practices.
- Included buy-down on equipment, 20% up to $5,000.
- Results:

Cost share on 117 pieces of equipment

40,000 acres received treatments – sediment, nutrients, pesticides

Restoration of Northern Wetlands of the Sandusky River Watershed

- Implemented by Ducks Unlimited to restore 100 acres of wetlands
- Focused on wetlands as a means of improving water quality, not just duck habitat.
- Results:

$100,000 in local funding leveraged

104 acres of wetlands restored along Lake Erie Coast

HSTS Replacement Program – EPA Section 319 Grant, 2004

- Replacement of 169 HSTS systems in 5 counties.
- New HSTS rules will impact our 3rd and final year.
- Results:

Almost ½ of goal approved for replacement, still monitoring effect of new HSTS rules.

Working On Vacation – Las Vegas

Watershed Planning, Coastal Management Assistance Grant, 2005

- Funding Development of Watershed Action Plan in Sandusky River - Tiffin
- Focus is on addressing Coastal Management Measures
- Results:

Jury is out… measures have been addressed in Honey Creek, so should be addressed here as well.

Agricultural Self-Assessment, OEPA Environmental Ed., 2005

- Delivers Farm Bureau's Agricultural Environmental Self Assessment to 160 farmers, with a focus on CSP.
- Influence how dollars are spent by landowners, which greatly exceeds the value of the grant.
- Results:

46 farmers participated in year 1. Nine sessions scheduled through March 2007

H.C. Sediment Control Grant, Great Lakes Commission, 2005

- Implementation of practices on select maintenance ditches.
- Applied in 2006 to implement larger scale project in Rock Creek.
- Results:

Project concludes December 2006

75% of 1600 acres enrolled as of June 1.

The ¼ Mile Log Jam

Cover Crops, National Fish and Wildlife Foundation, 2006

- Approx. 1000 acres of cover crops
- Goal is to affect soil tilth, and runoff.
- Results:

See me in 2 years…

B.S. Sediment Control Grant, Great Lakes Commission, 2006

- Based on the Honey Creek Project from 2005.
- Added additional practices, and would work with NFWF project on same area.
- Results:

Lets not get ahead of ourselves.

Rock Ck. Sediment Control Grant, Great Lakes Commission, 2006

- Grew out of Honey Creek project in 2005
- Includes practices suggested by local farmers – i.e. repair of waterways.
- Results:

Coordinator Grant, Watershed Coordinator Grant Program, 2007?

- Submitted June 2007 – based on implementation of HC WAP.
- Funding would be 3 years at $30K per year.
- Results:

What's on the Horizon

- Development of WAP's
- Land use practices
  - junk in, junk out
- Influence how landowners spend their $
- Long-term & "permanent" solutions

Thank You

CEAP/SWPI in the Upper Big Walnut Creek Watershed

Kevin W. King
and
Norman R. Fausey
USDA-ARS
Soil Drainage Research Unit

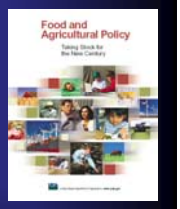
CEAP from a National Perspective

Why CEAP?

- The Federal Government's single largest environmental improvement program in agriculture is the Conservation Reserve Program which had 34 million acres enrolled at an annual cost of $1.6 billion in 2002.
- The Environmental Quality Incentive Program may provide as much as $6 billion over the life of the Farm Bill (2002 to 2007).
- New programs like the Conservation Security Program need tools that document environmental benefits to justify payment on existing conservation management practices.

Congressional Directive

- Congress and OMB directed USDA to conduct an assessment of the effects of conservation practices.
- NRCS was identified as the lead agency.
- NRCS requested assistance from ARS in quantifying the environmental effects of conservation practices at the watershed scale.

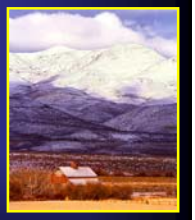


The Focus of CEAP

- The purpose of CEAP is to quantify the environmental benefits of conservation practices implemented under the 2002 Farm Bill.
- The initial focus is on cropland.
- Future plans include assessments for wildlife, grazing lands, and wetlands.

CEAP Has Two Major Components

- The NRCS-led **National Assessment** provides estimates of conservation benefits at the national scale.
- The ARS and NRCS-led **Watershed Assessment Studies** provide for more detailed information on conservation effects/benefits in selected benchmark watersheds.



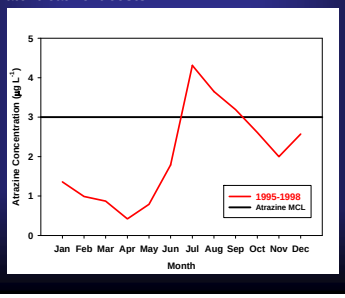
The Watershed Assessment Study Categories

- Agricultural Research Service (ARS) Benchmark Watersheds
- Special Emphasis Watersheds (NRCS)
- Competitive Grants Watersheds (CSREES)

City of Columbus Data

Problem:

- agricultural chemicals in metropolitan drinking water supplies
- health advisory levels exceeded
- excessive water treatment costs

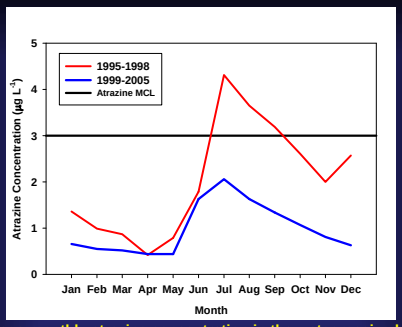


Solution:

1) Use of PAC to scrub water

2) Address source of problem

EQIP (595 pest mgt.) practices
- incorporation
- reduced rate
- alternative herbicide



Average monthly atrazine concentration in the water received at a Columbus, OH drinking water treatment facility coming from the Hoover Reservoir before (1995-1998) and after (1999-2005) EQIP implementation.

Impact:

- Economic: Investment $1.2 mil.
  Savings $3.1 mil.
  $2.58 return on every $ invested in the practice
- Safe, lower cost drinking water supply
  Reduced atrazine levels in Hoover Reservoir
- Voluntary environmental stewardship

USDA-ARS-SDRU CEAP Efforts

Background (SWPI)

- 2002 – SDRU initiates research in Upper Big Walnut Creek watershed as part of the Source Water Protection Initiative (SWPI)
  - focus is on hydrology and water chemistry
  - development of best management practices to ensure drinkable water

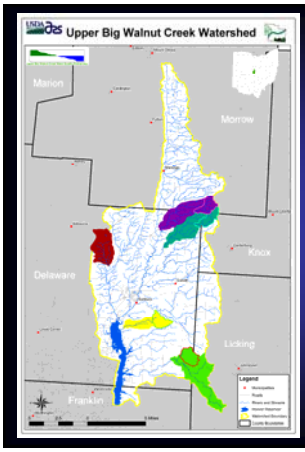
Background (CEAP)

2003 – Upper Big Walnut Creek watershed selected as one of 14 benchmark watersheds in ARS watershed assessment study as part of the Conservation Effects Assessment Project (CEAP)

- focus is on determining the environmental benefits of USDA conservation practices funded through the Farm Bill

- SDRU research efforts expand into ecology and soil quality

- OSU economic assessments begin



SWPI/CEAP Research

Objective: Measure and quantify the effects of innovative conservation practices, source water protection practices, and land use management on 1) water quality and quantity, and 2) lotic ecosystems at the field, farm, and watershed scales in the Upper Big Walnut Creek watershed

Conservation Programs

- EQIP (Environmental Quality Incentive Program) – USDA conservation program provides technical and financial assistance to treat identified natural resource concerns on crop land
  - $1.2 million dollars in EQIP contracts between 1999 to 2005 to reduce atrazine use
  - 5 year enrollment

- Upper Big Walnut Creek CREP (Conservation Reserve Enhancement Program)– state and federal program within watershed provides financial incentives to implement practices designed to reduce agricultural nonpoint pollution, particularly atrazine
  - Focus on establishment of riparian buffers within cropland
  - Enrollment 14 to 15 years

Water Quality and Quantity

Concern:

- Atrazine levels within the Hoover Reservoir

  - Hoover Reservoir serves as source of drinking water for Columbus, Ohio

  - Atrazine levels have periodically exceeded human advisory level of 3 µg/L

    July to Sept. 1997 - atrazine levels ranged from 5.2 to 5.8 µg/L

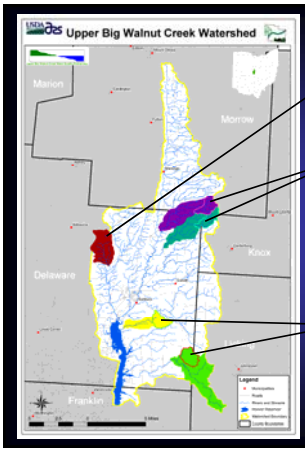
- Urbanization of watershed

Objective:

- Evaluate the influence of conservation practices and land use on the water chemistry and hydrology of streams in the Upper Big Walnut Creek watershed

Approach & Experimental Design

- Field measurements and modeling
- Influence of conservation practices
  - Four watersheds
  - Before-After-Control-Impact (BACI) Design
  - Paired watersheds
    - Control watershed – lacking or low levels of conservation practice
    - Treatment watershed – high levels of conservation practice
    - 1st practices to be tested - precision nutrient management & pest. management
  - 2 years of baseline data before implementation of practice
- Influence of changing land use
  - One watershed
  - Before – after design
  - Assessment began 2004

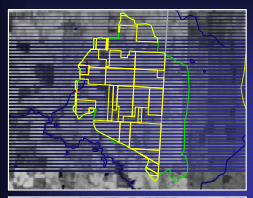


Urbanizing watershed

Paired Streams

Paired Ditches

Paired Drainage Ditches



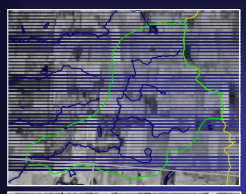
A-1

Drainage area	1121 ac.
Watershed slope	1-2 %
Urban	0.1 %
Agriculture/open	95.3 %
Shrub/scrub	0.0 %
Wooded	4.5 %
Wetlands	0.1 %

B-1

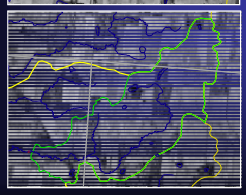
Drainage area	960 ac.
Watershed slope	1-2 %
Urban	0.1 %
Agriculture/open	88.9 %
Shrub/scrub	0.1 %
Wooded	10.4 %
Wetlands	0.3 %

Paired Streams



C-1

Drainage area	1085 ac.
Watershed slope	3-5 %
Urban	0.2 %
Agriculture/open	72.3 %
Shrub/scrub	0.4 %
Wooded	26.6 %
Wetlands	0.4 %



D-1

Drainage area	1058 ac.
Watershed slope	3-5 %
Urban	0.1 %
Agriculture/open	64.9 %
Shrub/scrub	0.8 %
Wooded	33.3 %
Wetlands	0.9 %

Water Chemistry & Hydrology Measurements

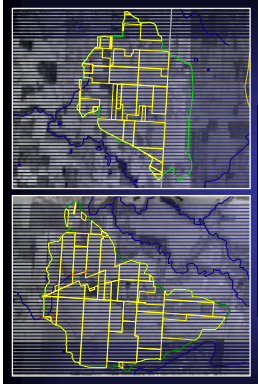
- Flow and time based sampling
- Discrete and weekly composites
- Subsurface and surface discharge
- Precipitation and other climate variables
- Nutrients
  - Nitrogen (TN, NO_3, NH_4)
  - Phosphorus (TP, PO_4)
- Total Suspended Solids
- Herbicides
  - Atrazine, Alachlor, Metolachlor, Simazine

Water Chemistry

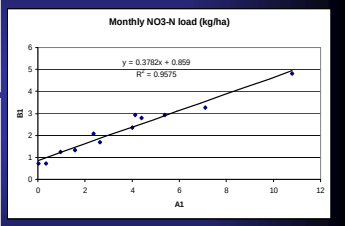
Preliminary Findings from 2005

NO_3-N, DRP, and Atrazine load from four small watersheds in UBWC.

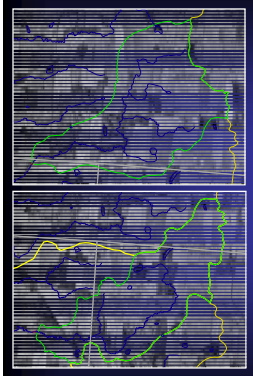
	A1	B1	C1	D1
Precipitation (inches)	32.7	35.8	38.1	38.1
NO_3-N Load (lb/ac)	39.0	23.9	9.9	18.5
DRP Load (lb/ac)	0.8	0.7	0.2	0.3
Atrazine Loss (lbs)	27.1	0.6	0.3	2.7



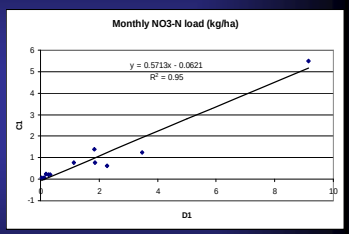
A-1: Control watershed



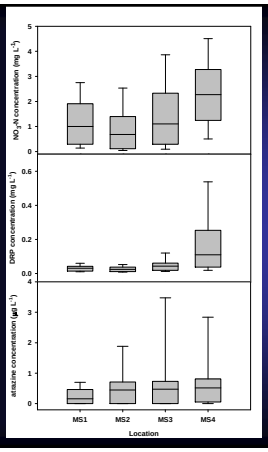
B-1: Treatment watershed



C-1: Treatment watershed



D-1: Control watershed



Urbanization Issues

Concentrations of NO_3-N, DRP, and atrazine on the main stem of UBWC.

Ecology Research

Concern:

- Habitat degradation of streams
  - Ohio EPA identified watershed as priority impaired watershed in 1998, 2002, and 2003 303 (d) lists
  - 2000 Ohio EPA monitoring results - 56% of streams sampled in watershed are not meeting aquatic life use designations set by EPA

Objective:

- Evaluate the influence of herbaceous riparian buffers on the physical habitat and stream communities in agricultural drainage ditches in the Upper Big Walnut Creek watershed

Experimental Design

- Nine streams
- Space For Time Design
  - Three ditches without herbaceous riparian buffer
  - Three ditches with herbaceous riparian buffers (CREP buffers)
  - Three streams with forested riparian zones (best case scenario)

What are the Habitat Characteristics of Agricultural Drainage Ditches?

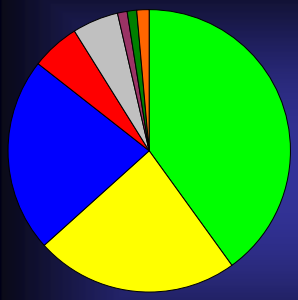
Habitat Characteristics of Drainage Ditches

Habitat Characteristic	Mean	Minimum	Maximum
Sinuosity	1.04	1.0	1.3
Gradient (m/m)	-0.1	0.2	-0.2
Top bank width (m)	9.0	6.2	12.1
Thalweg depth (m)	1.8	1.5	2.5
Wet width (m)	1.8	0.17	3.6
Water depth (m)	0.11	0.01	0.3
Water velocity (m/s)	0.02	-0.01	0.1

- shallow slow flowing water within low gradient, straight, enlarged channels

What Fishes Live in Agricultural Drainage Ditches?

Fishes Within Agricultural Drainage Ditches



- Documented 24 species from 6904 captures
- 7 most abundant species are also expected to occur in headwater streams

- Majority of the fishes are small, but some larger individuals are present

Future Plans

- Precision nutrient management
- Pest management
- Water table management
- Surface amendments (gypsum)

Summary

- Upper Big Walnut Creek watershed one of 14 benchmark watersheds in the ARS Watershed Assessment Study – one component of CEAP
- Research within watershed expanded from a focus on source water protection to broad assessment of conservation practices
- Ongoing research in the watershed involves assessment of water quality, ecology, soil quality, and economics
- Initial results will be provided to NRCS to use in their report to Congress on the 2007 Farm Bill

Acknowledgements

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- R. Dunn, L. Winters, and City of Columbus provided water chemistry information from selected streams and the Hoover Reservoir
- America's Clean Water Foundation
- T. Edwards, J. Hunter, and NRCS for landowner and site information
- A. Brate and T. Shaw for allowing us the use of a RTK unit, and L. Brown and E. Desmond for allowing us the use of a total station
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- We also are grateful to those landowners within the Upper Big Walnut Creek watershed who gave us permission to work on their property
- D. Binder, T. Terawaki, A. Houser, D. Lantz, W. Beery, P. DeArman, and 16 others from university, state, federal, and non-profit organizations contributed to the OSU Economic Assessment

Research at the River/Bay/Lake Interface

Jeffrey M. Reutter, Director
Ohio Sea Grant College Program and Stone Laboratory
Heidelberg College
28 June 2006

Areas of Need

- Research and Information Coordination
- Modeling
- Ecosystem Management
- Nutrient Loading
- Impact of Land Use Changes
- Fisheries

Sea Grant Thematic Areas

1. **Aquaculture**
2. **Biotechnology**
3. **Coastal Communities**
4. **Coastal Hazards**
5. **Digital Ocean**
6. **Ecosystems & Habitats**
7. **Fisheries**
8. **Marine Science Literacy**
9. **Seafood Science**
10. **Urban Coasts**
11. **Aquatic Invasive Species**

Priorities for Research

<u>High-Priority Areas</u>
Ecosystems and Habitats
Aquatic Invasive Species
Fisheries
Coastal Communities and Economies

Priorities for Research

<u>Medium-Priority Areas</u>
Biotechnology
Marine and Aquatic Science Literacy
Urban Coasts
Aquaculture

Priorities for Research

<u>Low-Priority Areas</u>
Coastal Natural Hazards
Digital Ocean
Seafood Science and Technology

The Public's Basic Questions

- Can I eat the fish?
- Can I drink the water?
- Can I swim in the lake?

Research and Information Coordination

- **Great Lakes Regional Research and Information Network (GLRRIN)**
- **IJC, CGLRM Research Coordination Strategy**
- **GLOS—Education and Outreach Coordinating Committees**

Great Lakes Regional Research and Information Network (GLRRIN)

Objectives

1) To leverage Sea Grant's university capabilities (research, education and outreach) with a broad range of Great Lakes stakeholders (users, general public, managers, and research scientists) to identify and prioritize critical resource management problems and the associated research and information needs necessary for practical solutions and to develop a strategy and network to facilitate, and enhance the value of, Great Lakes research, education and outreach.

Objectives

2) To build upon the LEMN model and establish a voluntary, non-regulatory, binational structure for coordinating, communicating and collaborating (3 C's) on research, education, and outreach efforts on each of the Great Lakes and an overall network for the entire region.

Objectives

3) To combine the individual networks from each of the five Great Lakes into a regional network to: identify and prioritize research, education, and outreach needs and gaps within each lake and the region as a whole; facilitate the development of multi-disciplinary, multi-agency, and multi-investigator research, education, and outreach proposals, projects, and programs; improve data management and the development of the Great Lakes Observation System (GLOS) within the Integrated Ocean Observation System (IOOS); and suggest standardized procedures for similar kinds of research and monitoring activities being conducted on each of the Lakes.

Objectives

4) To provide an ongoing platform (network) for coordination, collaboration, communication and resource sharing and assist the Council of Great Lakes Research Managers (IJC) in developing and implementing its Great Lakes Research Strategy. This network will provide the broad user and stakeholder input needed for bottom-up needs assessments for research, education, and outreach and to evaluate the effectiveness of the research strategy.

Objectives

5) To support and add value to existing regional management and coordination groups including the LaMPs, RAP groups, Lake Technical Committees of the Great Lakes Fisheries Commission, Council of Great Lakes Research Managers of the IJC, etc.

Lake Erie Millennium Network

Jeff Reutter, Ohio State University, Ohio Sea Grant and Stone Lab, Director

Jan Ciborowski, U. Windsor, Great Lakes Institute for Environmental Research

Russell Kreis, USEPA, Grosse Ile, Director/Branch Chief

Murray Charlton, National Water Research Institute, Environment Canada

Lake Huron Research and Information Network

Donald Scavia, University of Michigan, Michigan Sea Grant, Director

G. Doug Haffner, University of Windsor, Great Lakes Institute for Environmental Research

Leon Carl, US Geological Survey (USGS), Great Lakes Science Center, Director

David McLeish, Ontario Ministry of Natural Resources

Lake Michigan Research and Information Network

Anders Andren, University of Wisconsin, Wisconsin Sea Grant Director

William Sullivan, University of Illinois, Illinois/Indiana Sea Grant Director

Stephen Brandt, NOAA, Great Lakes Environmental Research Laboratory, (GLERL), Director

Paul Horvatin, US EPA, Great Lakes National Program Office (GLNPO), Monitoring and Reporting Branch, Chief

Lake Ontario Research and Information Network

Jack Mattice, New York Sea Grant, Director

Gary Sprules, University of Toronto

James Johnson, USGS

Bruce Morrison, Ontario Ministry of Natural Resources

Lake Superior Research and Information Network

Jeff Gunderson, Minnesota Sea Grant, Director

Canadian Univ Rep

Jack Kelly, USEPA Research Division, Duluth

Tom Pratt, Canada Department of Fisheries and Oceans

Overall Regional Network

Same composition as Lake Networks

+ A representative from academia from both sides of the border
+ A representative from a US federal agency
+ A representative from a Canadian agency

GLRRIN Composition

- the two academic members from each lake network (six US and four Canadian);
- US representatives from GLERL (NOAA), US EPA, USGS, USFWS, and USACE;
- Canadian representatives from the Ontario ministries of the Environment and Natural Resources, the Canada Department of Fisheries and Oceans, and the National Water Research Institute of Environment Canada;
- Bi-national representatives from the International Joint Commission (through the Council of Great Lakes Research Managers—Harvey Shear, University of Toronto and Canadian Co-Chair of the Council has agreed to serve in this position), the Great Lakes Fishery Commission, the Great Lakes Commission; and,
- a representative from the Great Lakes Sea Grant Extension Network, the Great Lakes Sea Grant Communications Network, and the Great Lakes COSEE.
- To guarantee a close working relationship between GLRRIN and the Council of Great Lakes Research Managers, IJC, Mark Burrows, the Council's Secretary, will also serve as the Secretary of GLRRIN.

Budget

$25,000 (US)/Lake for 2 years

$10,000/Lake for years 3-5

Modeling—Why Model?

- Accurately describe the situation.
- Demonstrate that we understand what is happening and why.
- Predict what will happen in the future with and without management action or change.
- Necessary for ecosystem management?

Modeling Lake Erie Nutrient Loading and the 1970s Dead Zone

- 1970's nutrient loading and eutrophication
- Liebig's Law of the Minimum
- Identified phosphorus as limiting nutrient
- Models allowed us to develop target loads calling for reduction from 29,000 to 11,000 tons
- Lead to rebirth of Lake Erie

Blue-green Algae Bloom circa 1970, Lake Erie

Lake Erie Dead Zones: Differences Between the 70s and Today

- 60s and 70s: Models allowed us to tell managers exactly what to do.
- Today: The scientific community is still trying to understand recent changes to the ecosystem and develop accurate models. Bottom line—decision makers are waiting for us to tell them what to do.
  - How do we eliminate the dead zone?

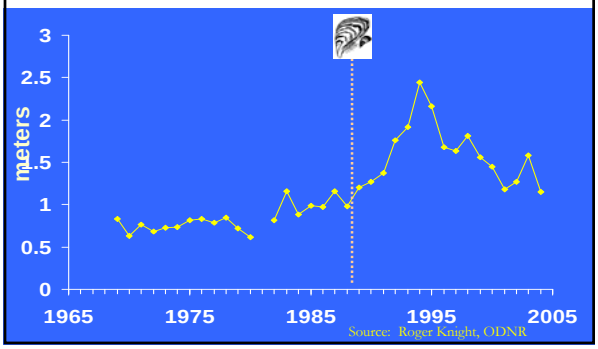
Ecosystem Management

- The Great Lakes should be this country's test bed for ecosystem management, and Lake Erie should be the test bed for the Great Lakes.
- While complete ecosystem management remains elusive, we should be able to do it better on Lake Erie than anywhere else.

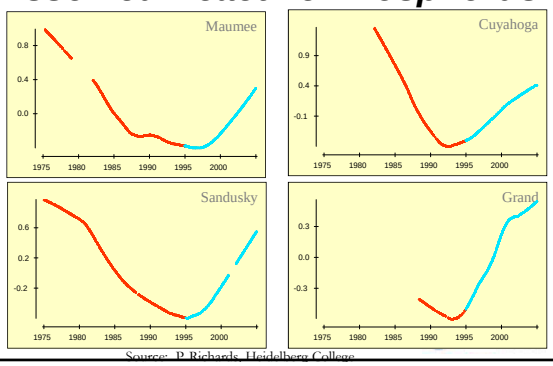
Nutrient Loading, Concentrations, and Impact

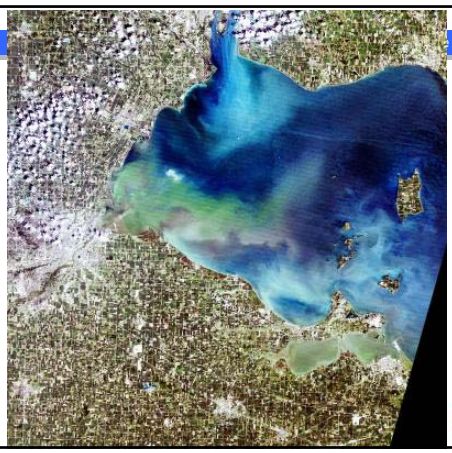
- Why is phosphorus concentration increasing?
- Why is water clarity decreasing?
- Relationship to Dead Zone?
- Relationship to HABs and AIS?
- To eliminate the Dead Zone, how much would phosphorus have to be reduced? Is it possible?
- Impact of climate change?
- Impact of factory farms?

Water Clarity is Declining ……

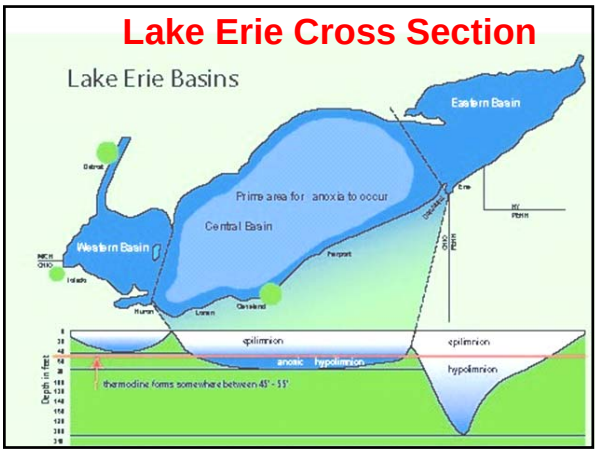


Dissolved Reactive Phosphorus

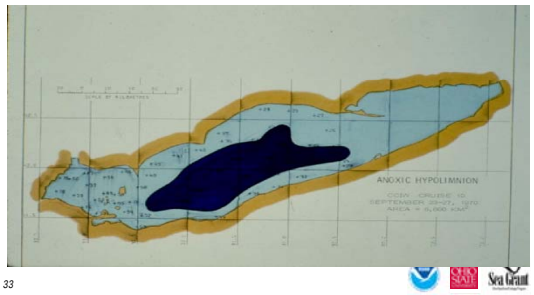




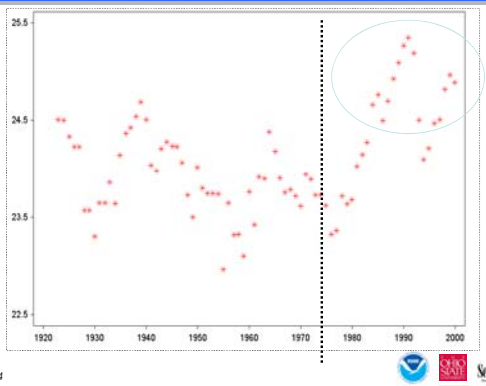
Lake Erie Cross Section



Anoxic Hypolimnion= "The Dead Zone"

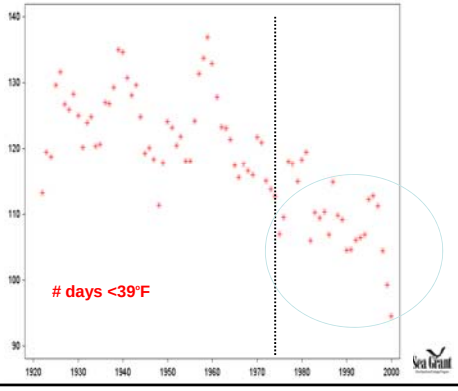


Summers Are Warmer…..



Source: Roger Knight, ODNR

Winters Are Milder……

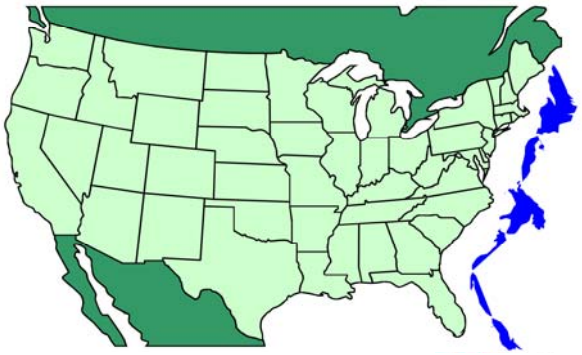


Source: Roger Knight, ODNR

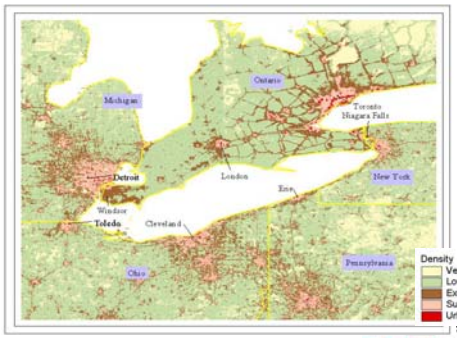
Impact of Land Use Changes

- Urban decentralization vs industrialization
- Exurbanization
- Habitat loss, e.g. wetlands
- Habitat "gain," e.g. AOC cleanup, dam removal

Great Lakes Coastlines



Current Population Patterns



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US Lake Erie Counties Land Use Change, 1982-1997

Land Use	1982 acres	%	1997 acres	%	Change	%Change
Cropland	1,652,600	36%	1,479,500	32%	-173,100	-10.5%
Pasture	355,400	8%	224,800	5%	-130,600	-36.7%
Forest	1,336,600	29%	1,375,500	30%	38,900	2.9%
Urban	1,224,600	27%	1,468,700	32%	244,100	19.9%
					Source: NRI	

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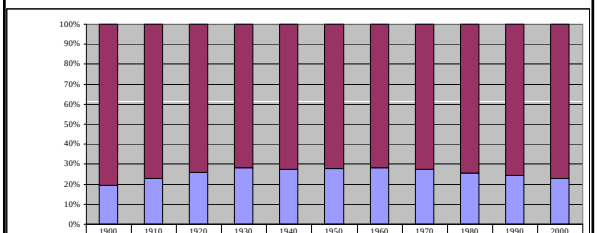
Ohio Lake Erie County Population, 1900 - 2000



	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
Ohio Remainder	3,342,707	3,682,599	4,256,263	4,772,319	5,006,370	5,730,560	6,982,495	7,720,076	8,052,566	8,207,397	8,750,595
LE Counties	814,838	1,084,522	1,503,131	1,874,378	1,901,242	2,216,067	2,723,902	2,931,941	2,745,064	2,639,718	2,602,545

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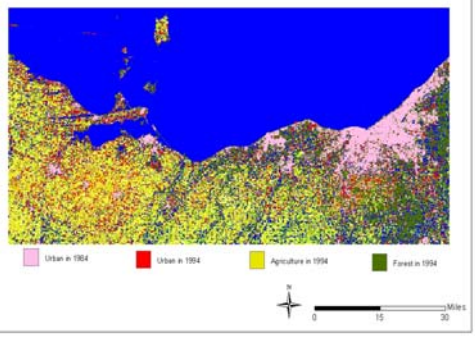
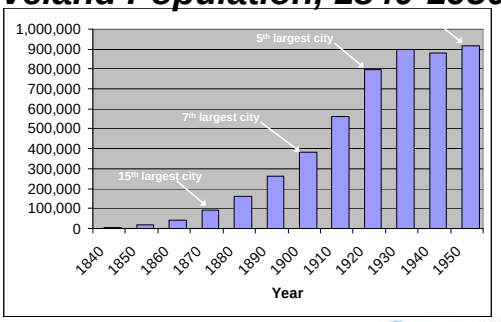
Amount of urban land has increased… 1994 Land Use



Cleveland Population, 1840-1950



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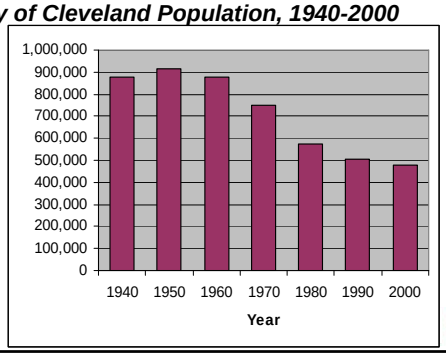
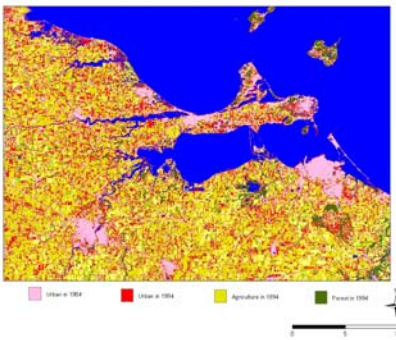
Urban Decentralization

City of Cleveland Population, 1940-2000



Trends in Low-Density Urban Land



Fisheries

- Impact of Sandusky River, Maumee River, and Western Basin Reefs
- Relationship between year-class strength and brood stock
- What determines year-class strength

For more information

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Ohio State Univ.
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Col, Oh 43212
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www.ohioseagrant.osu.edu/

Stone Laboratory
Ohio State Univ.
Box 119
Put-in-Bay, O 43456
614-247-6500

Evaluating Program Effectiveness at the Watershed Level

R. Peter Richards
National Center for Water Quality Research
Heidelberg College
Tiffin, Ohio 44883

Desirable aspects of field research

- Manipulation, not just observation
- In control of all aspects of experiment
- No extraneous influences
- Various levels of treatment
- A control (null experiment)
- Replication

Desirable aspects of field research

- Manipulation, not just observation
- In control of all aspects of experiment
- No extraneous influences
- Various levels of treatment
- A control (null experiment)
- Replication
- Minimize the Variance!

Research at the plot scale

- √ Manipulation, not just observation
- √ In control of all aspects of experiment
- √ No extraneous influences
- √ Various levels of treatment
- √ A control (null experiment)
- √ Replication

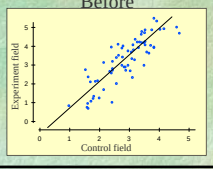
Research at the field scale

- √ Manipulation, not just observation
- ? In control of all aspects of experiment
- ? No extraneous influences
- ~ Various levels of treatment
- √ A control (null experiment)
- ~ Replication

Inferring cause & effect

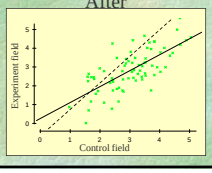
- Controls, treatment levels, replication build confidence that your manipulation *caused* the observed change(s)
- Before-after, paired-field design

Before



Apply Treatments

After



Research at the watershed scale

- ~ Manipulation, not just observation
- – In control of all aspects of experiment
- – No extraneous influences
- – Various levels of treatment
- ~ A control (null experiment)
- – Replication

Research at the watershed scale

- Long lag time between management action and water quality response
- Little control over the control watershed
- Limited, untargeted implementation
- Rarely have adequate funding for "before" monitoring
- Other things going on confound the signal
- Often we just observe, rather than experimenting

Watershed research as a lab experiment

- A large beaker in a lab with no door
- Several experiments already going on in the beaker
- Impure reagents
- No distilled water
- Experiment takes 3 hours but you're only allowed 15 minutes
- The CSI Miami analogy: you find the beaker after the experiments are done, and you have to figure out what happened in the beaker and why!

Research at the watershed scale

- So there are good reasons it's hard to do!
- In spite of these considerable problems and drawbacks, we need to keep trying to provide evidence of success at the watershed scale!
- Managers need to come to understand how hard this is, and not have unrealistic expectations!
- SWCS Workshop in Kansas City, October 11-13, "Managing Agricultural Landscapes for Environmental Quality", one theme is "Realistic Expectations"…

Case Study: Lake Erie CREP

- Derivation of WQ Goal
- Approach to evaluation
- Where do we stand with meeting the goal?
- Recent work on longer term trends

Setting the water quality goal

- One Index of Lake Erie Quality is tributary sediment loads.
- For 1991-1996, the average annual sediment load from the Maumee, Sandusky, and Cuyahoga Rivers is 1,500,000 metric tons
- Reduce this by 67%(!)

Setting the water quality goal

- Lake Erie CREP Implementation Goal: Protect 10% of farmed riparian acres
  - Protect 10% of riparian corridor => reduce loads by 10% or by 150,000 metric tons annually
  - Gradual implementation, assumed uniform over 10 years
  - Thus save 15,000 metric tons the first year, 30,000 the second year, etc.

Setting the water quality goal

Year of program	Sediment load reduction in this year	Total sediment saved to date
1	15,000	15,000
2	30,000	45,000
3	45,000	90,000
4	60,000	150,000
5	75,000	225,000
6	90,000	315,000
7	105,000	420,000
8	120,000	540,000
9	135,000	675,000
10	150,000	825,000

…plus 10 more years of loads reduced by 150,000 m.t./yr

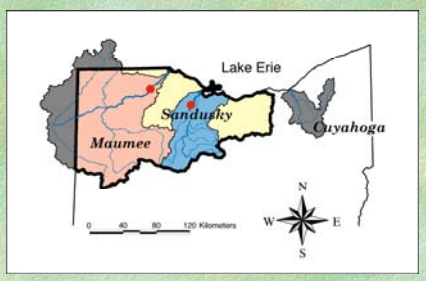
The water quality goal: notes

- We have no control watershed - just before and after in the CREP implementation area
- We don't really know what WQ response to expect from 10% implementation of BMPs
- We don't know anything about lag times
- The goal amounts to only a 1% change per year
- If we meet the goal, how do we know it's not just because of weather?

Evaluating the water quality goal: a few minor problems...

- The Cuyahoga River basin is not in the implementation area
  - so we need to exclude its loads
- Only Maumee basin in Ohio is in CREP
  - so we need to exclude loads not from Ohio
- Some of the Lake Erie CREP area is not monitored
  - so we need to extrapolate loads to cover that area

The evaluation approach: problems...



The evaluation approach: solving the problems...

- Recalculate the baseline loads using Maumee and Sandusky only (1991-1996)
- Assume sources of sediment are uniformly distributed across CREP area, and calculate adjustment factors to remove non-Ohio Maumee and add in unmonitored watersheds

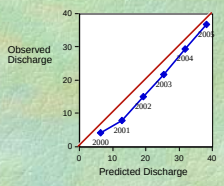
The evaluation approach: solving the problems...

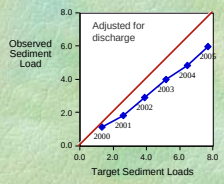
- Adjustment factor for Maumee: 71%
- Adjustment factor for unmonitored: 131%
- CREP Adjusted Load = 1.31(Sand+.71Mau)
- Baseline average annual load for CREP implementation area: 1,320,000 metric tons
- 150,000 ton reduction goal amounts to 11.7% instead of 10%

Initial results

- Total sediment "saved" after six years: 2.1 million metric tons.
- We weren't supposed to have saved that much until sometime in the year 2018!
- Unfortunately, a lot of the "savings" are associated with years of low discharge, which reduces the loads as well.
- After proportional adjustment to average discharge, still 1.9 million metric tons ahead.

Initial results





Note: these are cumulative loads and discharges

Indications

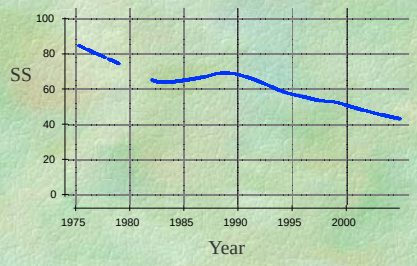
- We're looking good!
- But some or much of our "success" to date is due to weather effects that produced lower-than-expected flows….
- So keep your fingers crossed, and lets go for as much implementation as possible!

Weather Effects on Trends: A New Approach (for me, anyway)

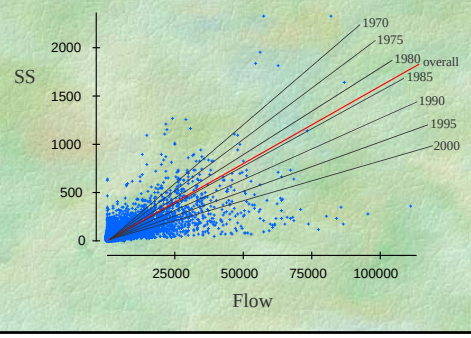
- Maumee only, not entire CREP area
- 30-period of record, not just CREP period
- Examine concentration-flow relationships in relationship to time

Weather Effects and Trends

- LOWESS smooth of Maumee SS:

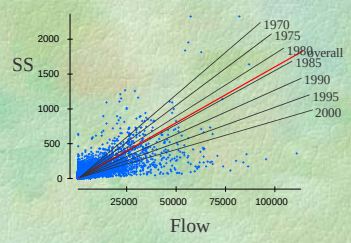


Weather Effects and Trends



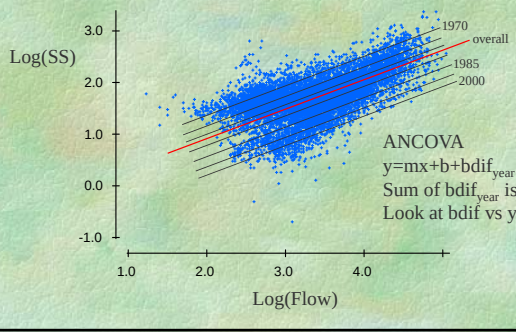
Weather Effects and Trends

- Need to do the analysis in log-log space…



$SS=k_y*Flow$
$\log(SS)=\log(k_y*Flow)$
$\log(SS)=\log(k_y)+\log(Flow)$
constant
(part of intercept term)

Weather Effects and Trends



ANCOVA
$y=mx+b+bdif_{year}$
Sum of $bdif_{year}$ is 0
Look at bdif vs year

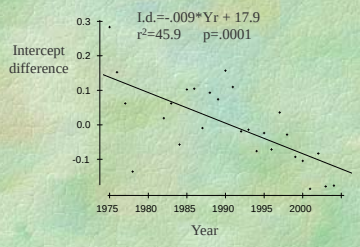
Weather Effects and Trends

Analysis of Variance For **LogSS**
No Selector
9102 total cases of which 62 are missing

Source	df	Sums of Squares	Mean Square	F-ratio	Prob
Const	1	26198.9	26198.9	234182	Š 0.0001
LgQ	1	565.480	565.480	5054.6	Š 0.0001
WY	26	105.821	4.07003	36.380	Š 0.0001
Error	9012	1008.21	0.111874		
Total	9039	1745.43			

Level of WY	Coefficient	Level of WY	Coefficient	Level of WY	Coefficient
1975	0.2831	1985	0.1021	1995	-0.0232
1976	0.1533	1986	0.1036	1996	-0.0708
1977	0.0616	1987	-8.924e-3	1997	0.0353
1978	-0.1354	1988	0.0931	1998	-0.0281
1979	no data	1989	0.0734	1999	-0.0931
1980	no data	1990	0.1569	2000	-0.1049
1981	no data	1991	0.1086	2001	-0.1853
1982	0.0202	1992	-0.0193	2002	-0.0822
1983	0.0620	1993	-0.0149	2003	-0.1774
1984	-0.0565	1994	-0.0767	2004	-0.1766

Weather Effects and Trends



Conclusion: highly significant decrease in sediment concentration as a function of flow over 30 years!

Weather Effects and Trends

- Further analysis shows:
  - Most of this change is associated with the "summer" months (May-October)
  - The Sandusky shows the same changes, though not as strongly

Conclusions

- Detecting water quality change at the watershed scale is difficult, for good reasons.
- Making a strong case that changes are responses to land management programs is even more difficult.
- With good data and appropriate analyses, however, the case can (and should) be made.