

Marcellus Shale Natural Gas Development and Impacts to Aquatic Resources

John A. Arway, Executive Director
Pennsylvania Fish & Boat Commission

Mission: To protect, conserve, and enhance the Commonwealth's aquatic resources and provide fishing and boating opportunities



Marcellus Gas Development Has Been a Challenge for Everyone

- **For Industry**
 - No one stop shopping for approvals
 - Foreign Environmental Regulations
 - New Landscape
- **For the Public**
 - Lack of information and much misinformation
- **For Regulators and Resource Agencies**
 - Limited Staffing
 - Out-Dated Statutory/Regulatory Authority

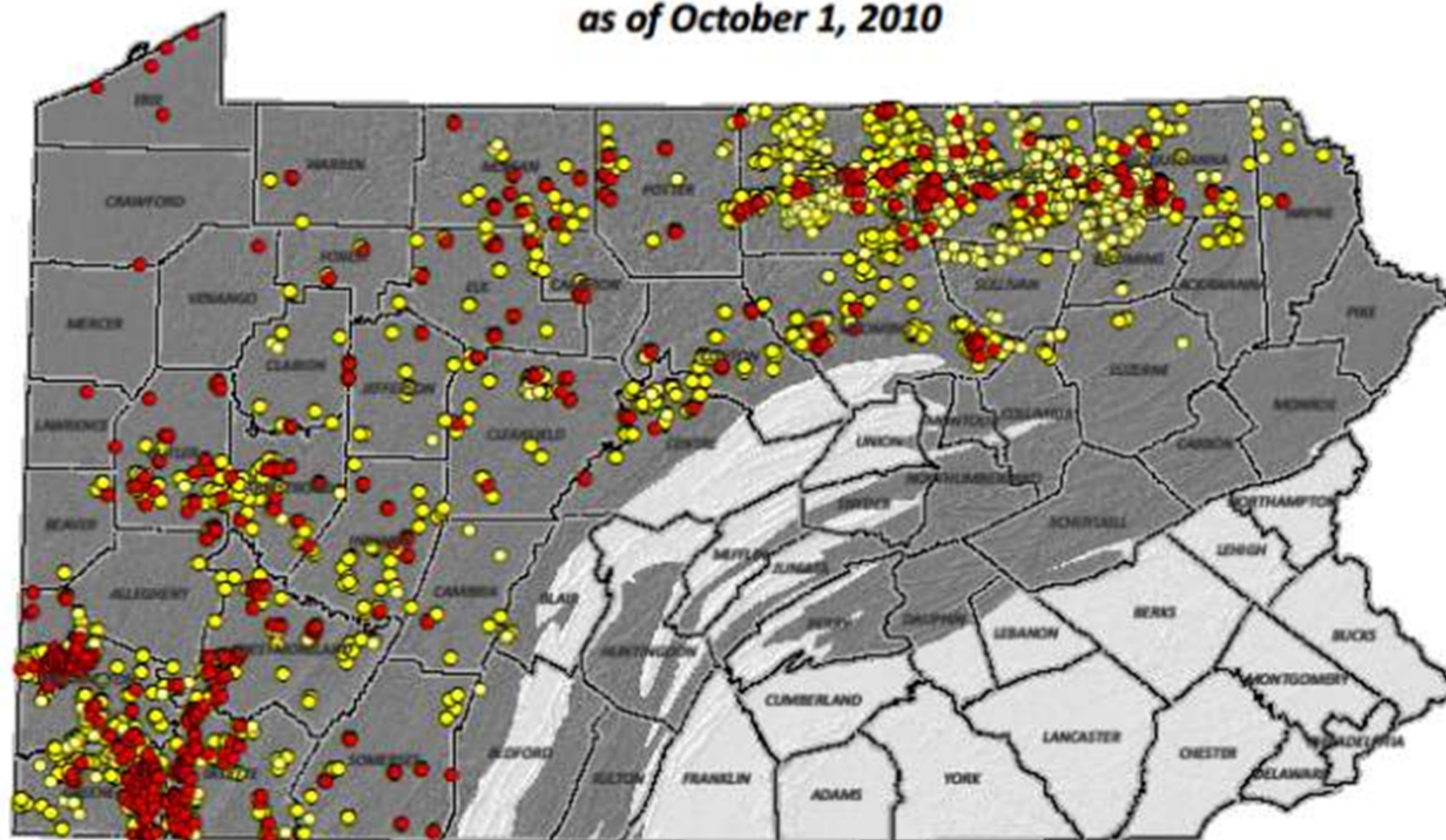


What are the Environmental Risks Associated with Marcellus?

- **GeoSeismic Surveys**
- **Habitat Fragmentation**
- **Access Road Construction**
- **Well Pad Development**
- **Drilling**
- **Water Withdrawals**
- **Water Storage**
- **Hydrofracturing**
- **Waste Disposal**
- **Pipeline Construction**
- **Compressor Stations**



Pennsylvania Marcellus wells as of October 1, 2010



● Active Permits (4510 permits)

● Completion reports received (645 wells)

■ Extent of Marcellus Shale in Pennsylvania

1:2,250,000

0 12.5 25 50 75 100 Miles

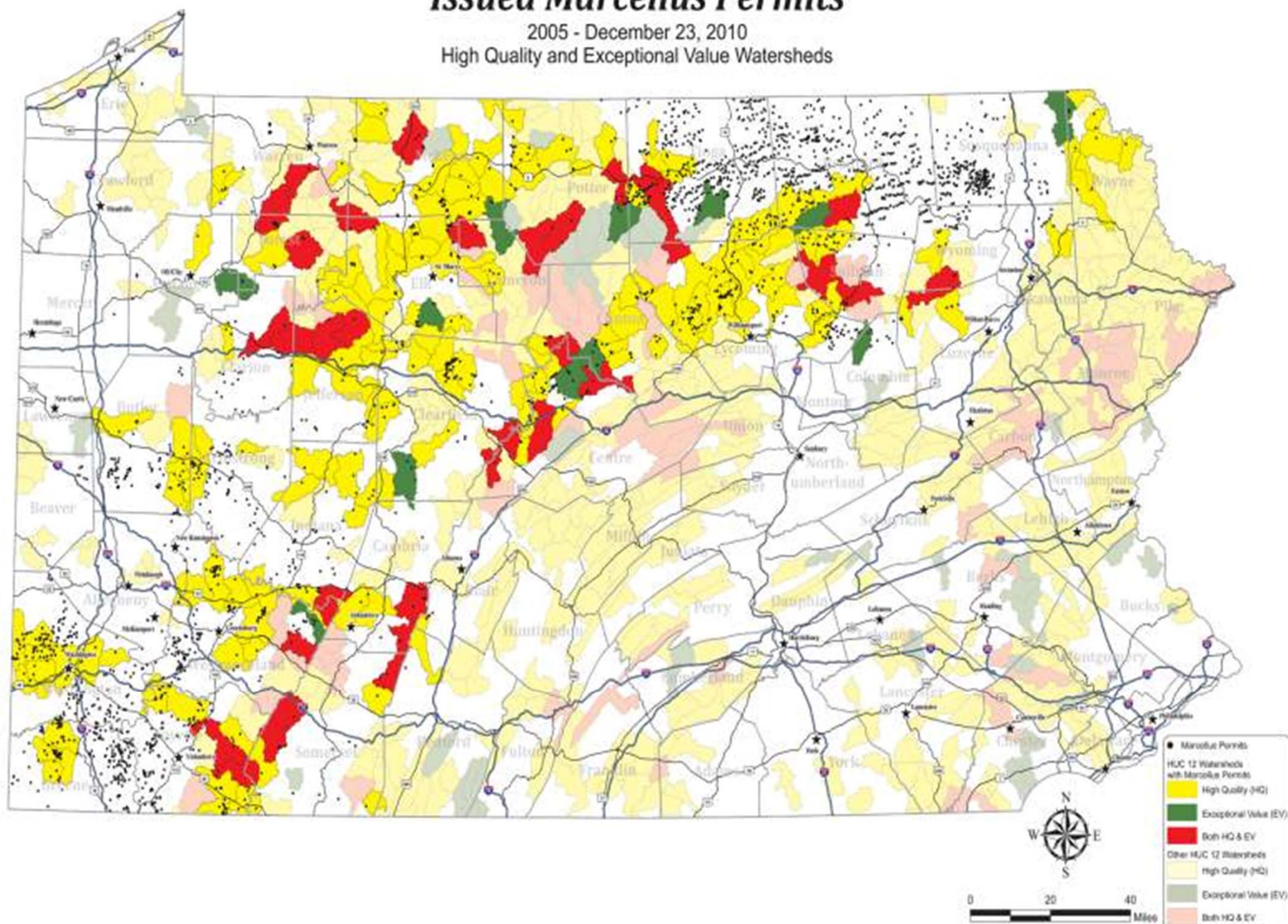
Data Source: Active permits, Pennsylvania Department of Environmental Protection,
www.depweb.state.pa.us, October 2010; Completion reports received, Pennsylvania Geological Survey,
October 2010;

For Display Purposes Only

Issued Marcellus Permits

2005 - December 23, 2010

High Quality and Exceptional Value Watersheds



PFBC Marcellus Well Site Inspection Results

- **November 2009 to February 2010**
- **175 sites within 1/8 mile of watercourse**
- **Water quality related problems were recorded at approximately 30% of the sites**



Areas of Major Environmental Risk to Aquatic Resources

- **Water quality**
- **Water quantity**
- **Stream & wetland encroachments**
- **E&S**
- **Cumulative impacts**



Water Quality

- Spills
- Fish Kills
- Illegal Discharges
- Ground Water Contamination
- Surface Water Contamination
- Stream Sedimentation



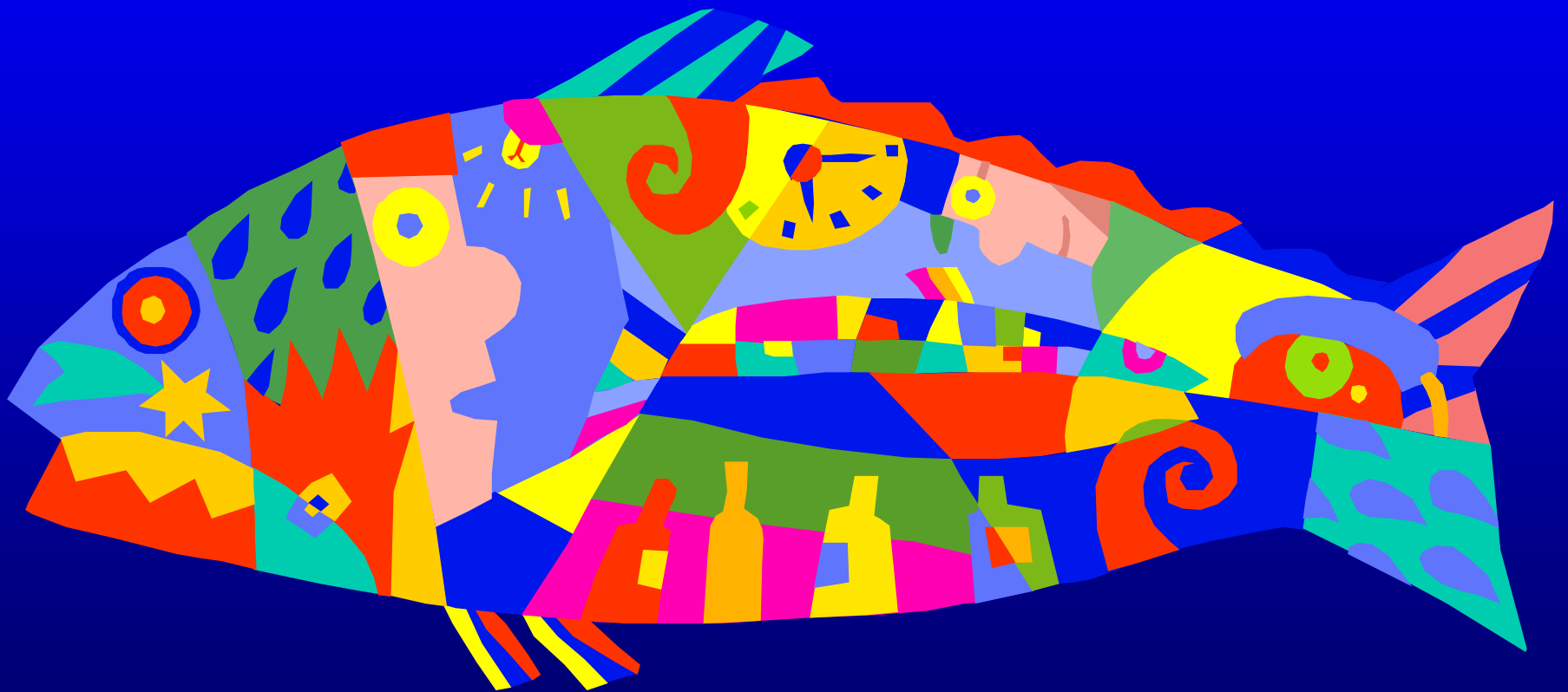
Characterizing the Waste

- Surfactants
- Organics
- TDS
 - 30,000 to 230,000+ mg/l
- Chlorides
 - 15,000 to 110,000+ mg/l
- Metals
 - Barium, Strontium
 - Selenium
- TENORM
 - Radium 226, 228
 - Gross alpha, beta
 - Uranium
 - Radon

(Source-EPA, Region 3)



Fish Consumption Advisories





Jan. 2010 Spring at base of well pad
Headwaters of UNT to Laurel Run (HQ), Clearfield County



Water Quality Results from a Spring Near Contaminated by a Marcellus Well

TDS- 3250 mg/l

Chloride- 1597.8 mg/l

Sodium- 410 mg/l

Hardness- 1241 mg/l

Strontium- 42270 ug/l

Barium- 12300 ug/l



After – with treatment



April 2011 Interim treatment to improve water quality
Headwaters of UNT to Laurel Run (HQ), Clearfield County





Surfactant Spill, Pine Creek, Lycoming County



Brine Treatment Plant – Conemaugh River

Brine Treatment Plant discharge – Conemaugh River



Spills







Contaminated shallow groundwater system/spring from spills and inadequate of containment of buried drill cuttings, Alex Branch (HQ), Clearfield County



Alex Branch (HQ) affected downstream of contaminated springs, Clearfield County

Erosion & Sedimentation Issues



E&S Failure, Elk Creek watershed (EV) Tioga County



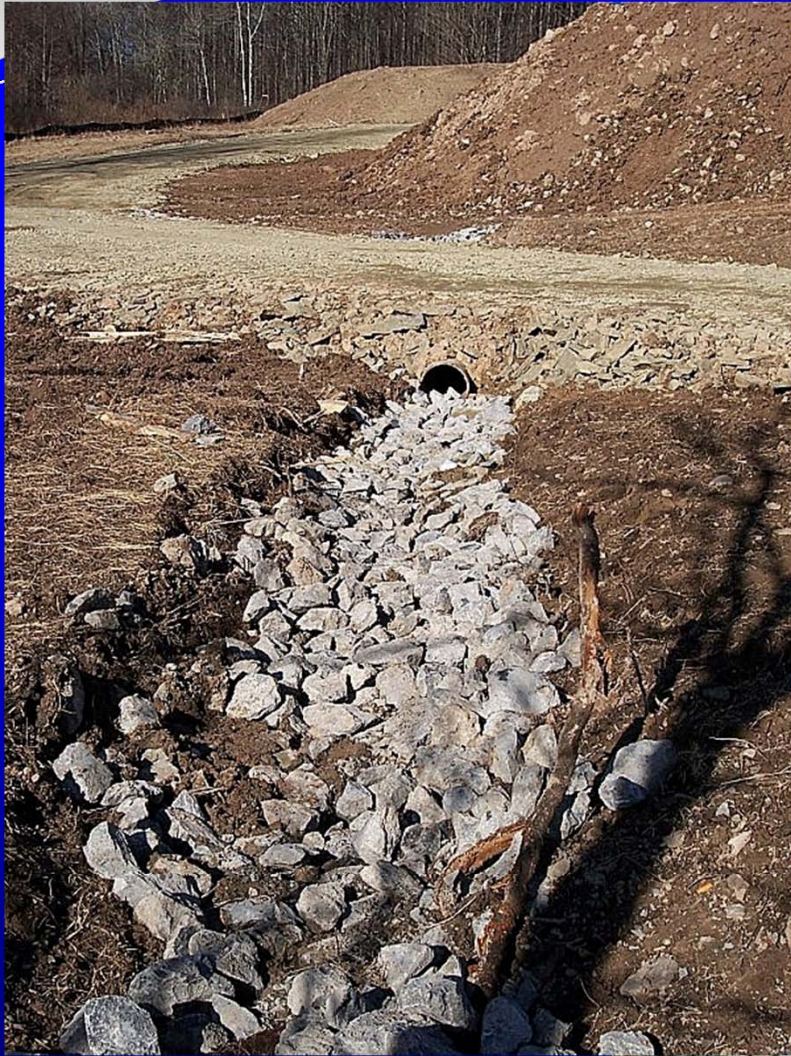
Access Road Construction



Existing Stream Crossing Extensions



New Road Culverts



Well Pad Development 5-20 Acres





Ineffective E&S controls on well pad, UNT to Potato Creek (HQ), McKean Co.



E&S Failure, Potato Creek watershed (HQ), McKean County



E&S Failure, Potato Creek watershed (HQ), McKean County



Confluence on UNT and Wetmore Run (HQ), Potter County



Upstream
Water sampling at well pad access road, UNT to Wetmore Run, Potter Co.

Downstream



Pipeline Construction



High Quality Watersheds, McKean Co.



Failure to provide adequate E&S controls during pipeline construction, HQ tributaries on State Game Lands in Potato Creek watershed, McKean County



Failure to provide adequate E&S controls during pipeline construction, HQ tributaries on State Game Lands in Potato Creek watershed, McKean County



Failure to provide adequate E&S controls during pipeline construction, HQ tributaries on State Game Lands in Potato Creek watershed, McKean County



Failure to provide adequate E&S controls during pipeline construction, HQ tributaries on State Game Lands in Potato Creek watershed, McKean County



Sediment choked stream due to E&S failure during pipeline construction, HQ tributaries on State Game Lands in Potato Creek watershed, McKean County



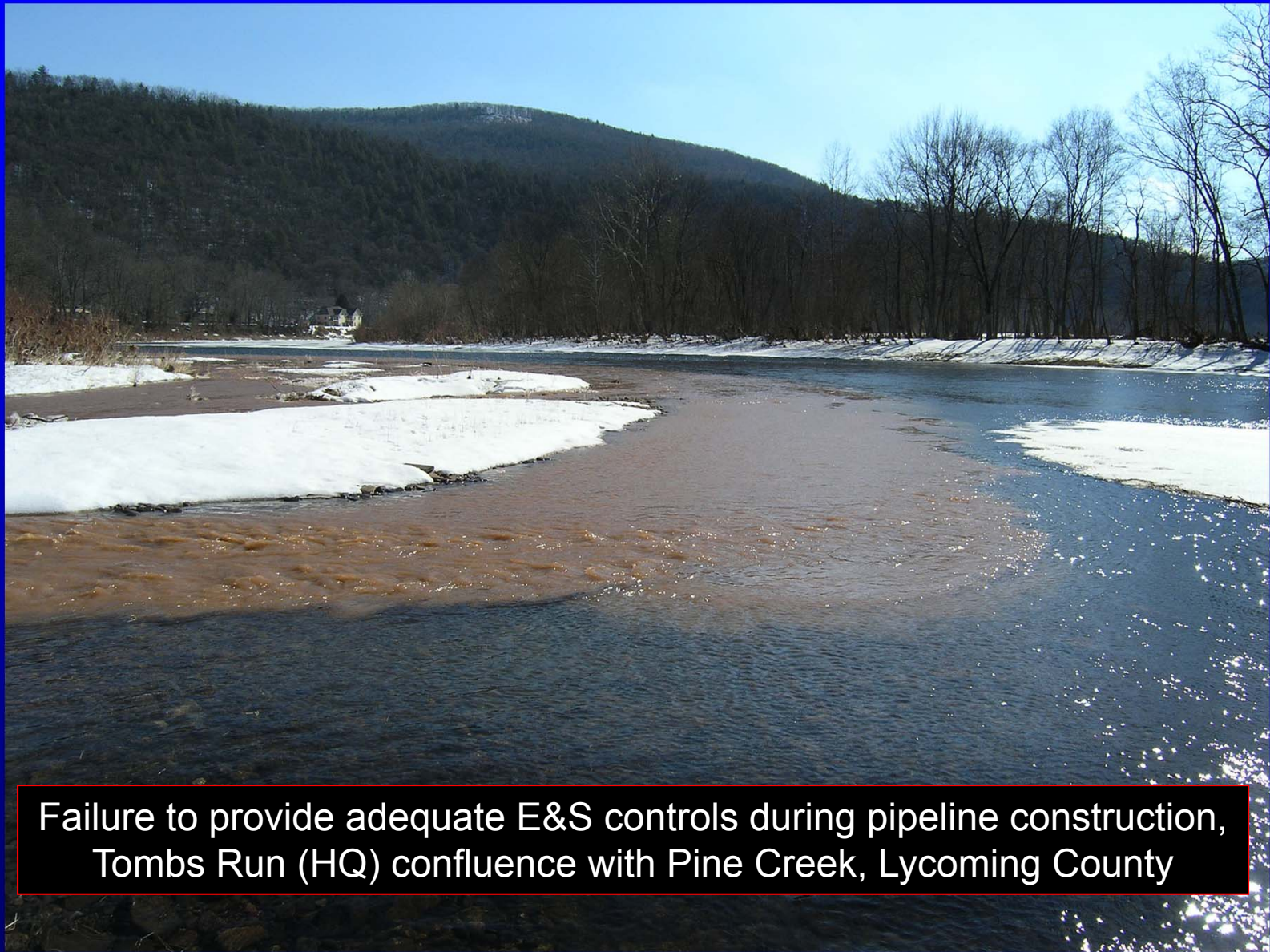
Failure to provide adequate E&S controls during pipeline construction, Elk Creek watershed (EV), Tioga County



Failure to provide adequate E&S controls during pipeline construction,
Tombs Run watershed (HQ), Lycoming County



Failure to provide adequate E&S controls during pipeline construction,
Tombs Run watershed (HQ), Lycoming County



Stream Boring





Exceptional Value Watershed, Tioga Co.



Boring "frac out", Elk Creek watershed (EV) Tioga County



Boring "frac out", Elk Creek (EV) Tioga County

Stream & Wetland Encroachments

- **Our Best Headwater Coldwater Streams (HQ and EV) coincide with the Marcellus**
- **Wells are on mountaintops in the headwaters of these streams**
- **Major Habitat Fragmentation Issues**
- **Impact to riparian stream buffers**





Well pad in forested wetland, UNT to Moshannon Creek, Clearfield County



PGE Cofferd Dam on Pine Creek May 12, 2011



PGE Cofferd Dam on Pine Creek May 19, 2011

Water Quantity

- Marcellus wells require millions of gallons of water for hydrofracturing
- Local Streams are usually too small to supply the demand
- Water is transported (hailed by truck or pipeline) and stored in ponds which may be repeated to re-stimulate wells
- Regulators directing industry to water suppliers & streams where water is available

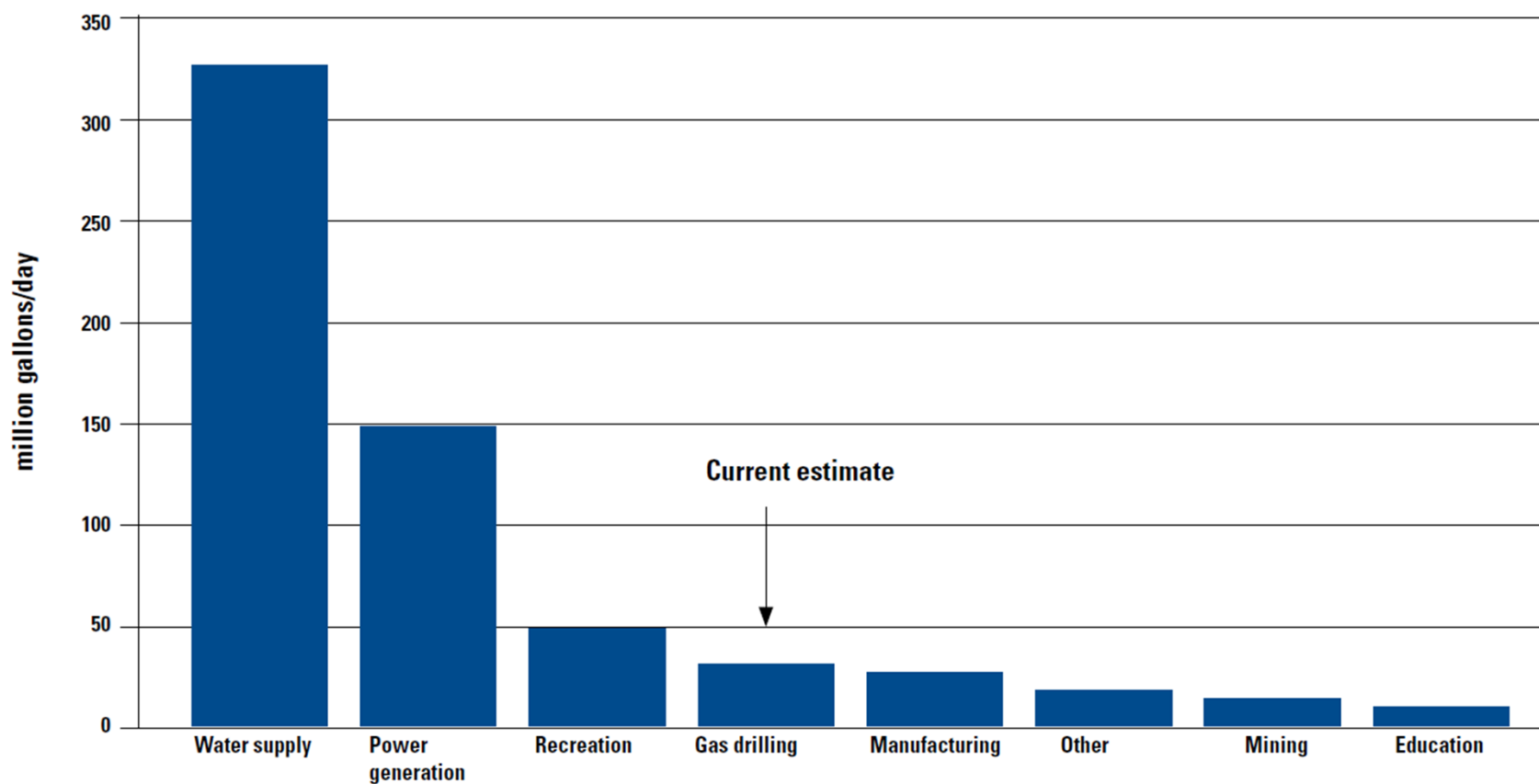


Water Withdrawals



Consumptive Use

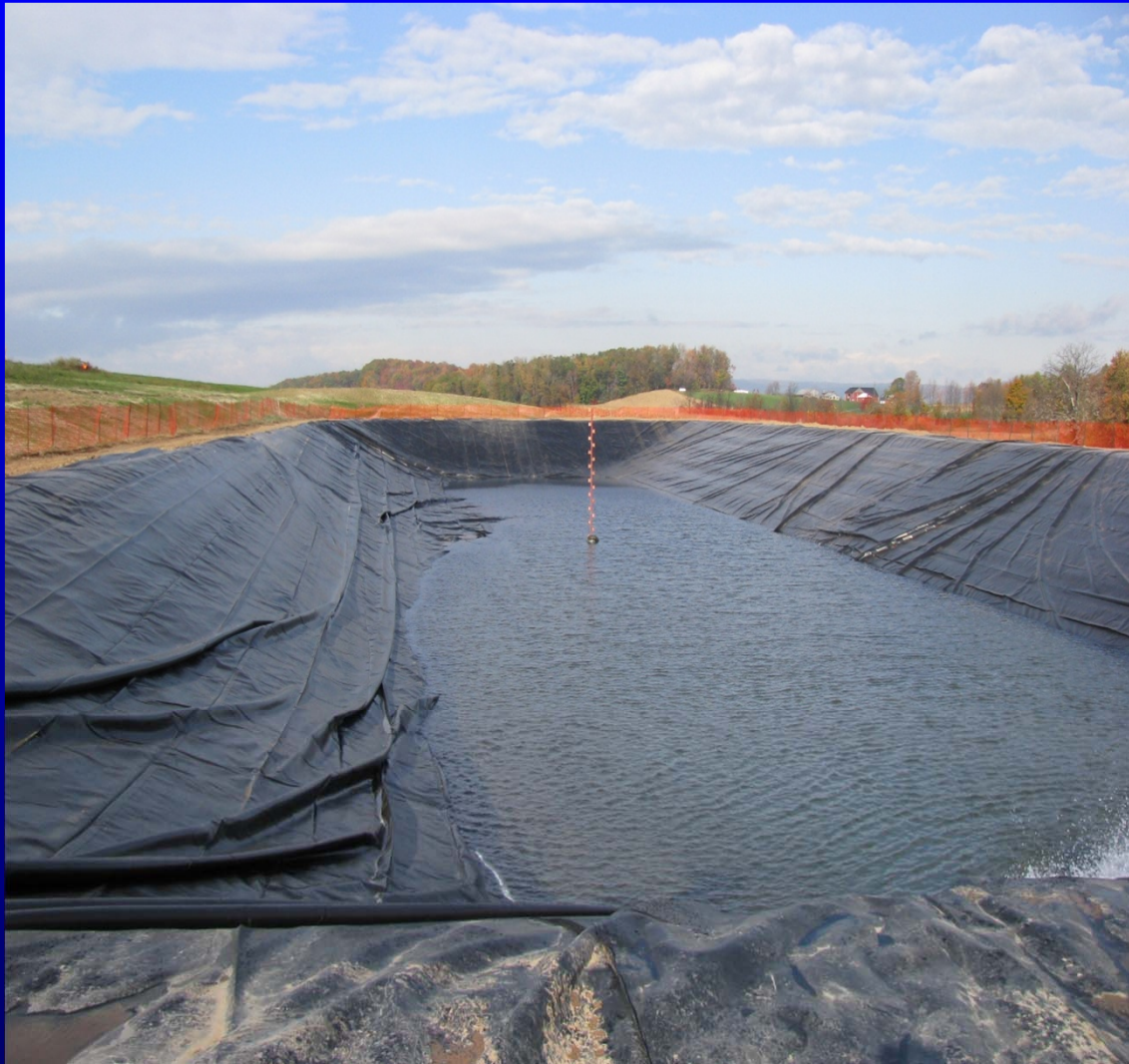
Figure 6. Maximum approved daily consumptive water use by various industries.



Source: Susquehanna River Basin Commission.



Water Storage



Hydrofracturing



Water Use

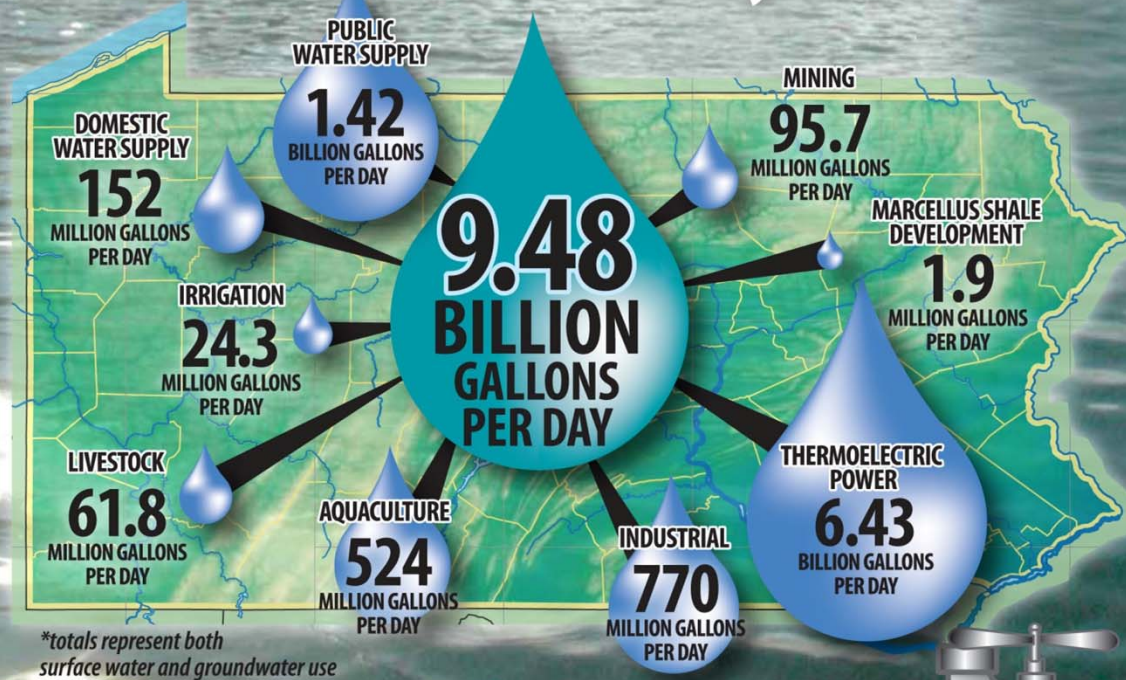
Table 1. Usage of water in hydrofracturing in the Susquehanna River basin in Pennsylvania, June 1, 2008–May 21, 2010.

	<i>Average</i>	<i>Minimum</i>	<i>Maximum</i>
Water injected for hydrofracturing (million gallons)	3	0.1	8.3
Water brought onsite that is used (%)	84	30	100
Injected water that is recovered (%)	10	1	57

Source: Susquehanna River Basin Commission



PA Water Withdrawals by Water Use*



Sources: J. F. Kenny, N. L. Barber, S. S. Hutson, K. S. Linsey, J. K. Lovelace and M. A. Maupin. 2009. *Estimated use of water in the United States in 2005*. U. S. Geological Survey Circular 1344. 52 p.

Marcellus Shale Gas Development Water Use: June 1, 2008 - May 21, 2010 Susquehanna River Basin Commission basin-wide reported daily use of 0.99 MGD expanded to statewide estimate. Water sources: 29% Public water supplies/71% Surface water withdrawals

1 MGD daily use in Susq. Basin ÷ wells drilled in Susq. Basin/wells drilled statewide=1 MGD ÷ (765/1428)

Water Quantity

MARCELLUS EDUCATION FACT SHEET



Water Withdrawals for Development of Marcellus Shale Gas in Pennsylvania

Introduction to Pennsylvania's Water Resources

Pennsylvania has considerable water resources both above and below ground. The state's surface water resources include more than 83,000 miles of streams and rivers, more than 4,000 lakes and reservoirs, hundreds of thousands of private ponds, and 120 miles of coastal waters, overall totaling

than those of some southwestern and mountain states where other shale fields are already in full-fledged gas production. The abundance of water in Pennsylvania is a double-edged sword for drilling. Water is needed for drilling, but drillers need to avoid affecting the numerous water wells, streams, lakes, and

PENNSTATE

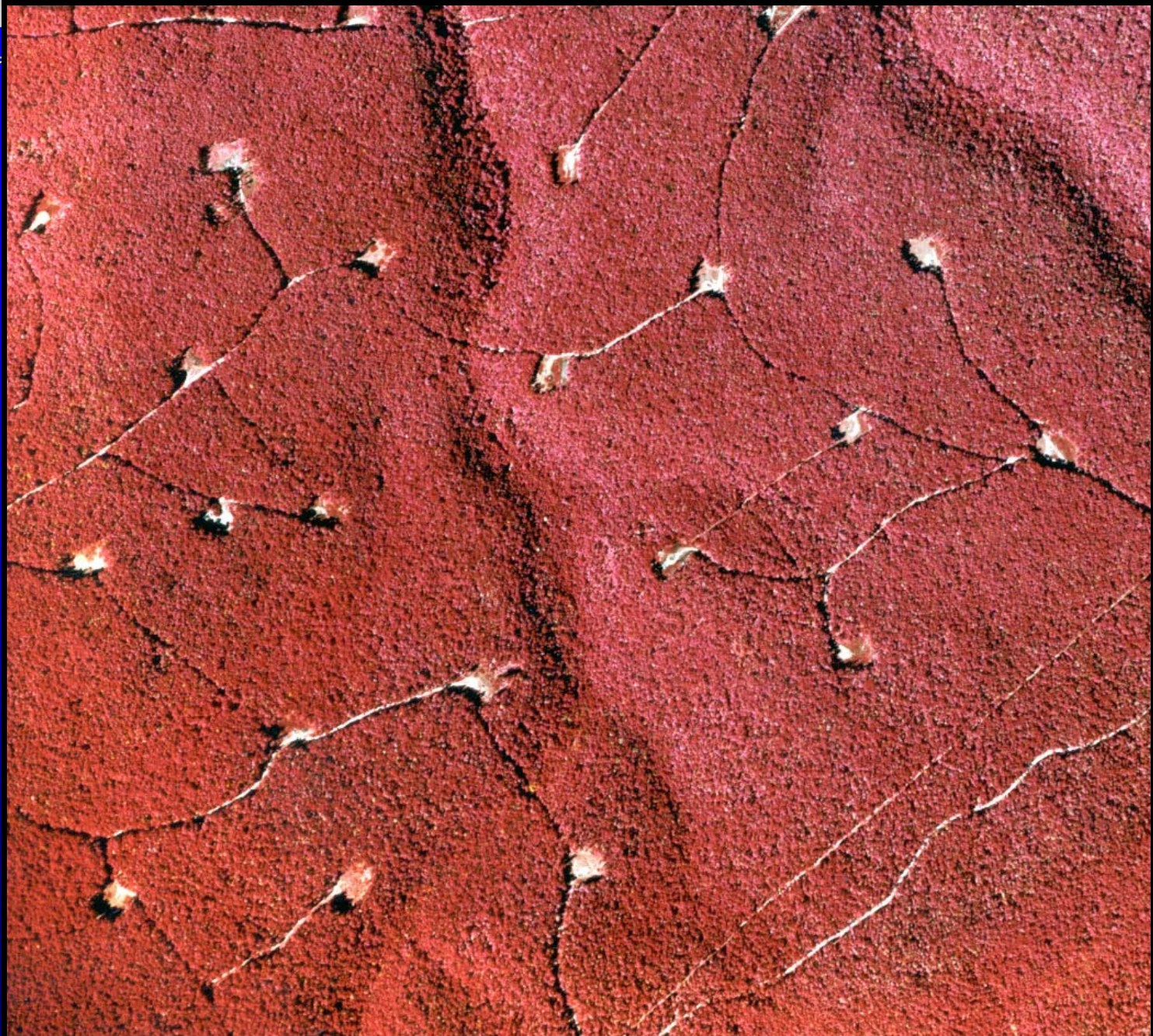


COLLEGE OF AGRICULTURAL SCIENCES • COOPERATIVE EXTENSION



Habitat Fragmentation





Cumulative Impacts

- **Potential for thousands of Marcellus wells to be developed in PA and across the Appalachians over many years**
- **Habitat becomes additionally fragmented with increasing development**
- **Well sites, gathering lines, transmission lines and access roads will increase over time**
- **More activity increases risk for accidents or emergencies**

Early study shows dense drilling impacts watersheds

By Laura Legere (Staff Writer)

Published: October 13, 2010

A preliminary study of Susquehanna County watersheds has found that high-density Marcellus Shale gas drilling might degrade streams regardless of how carefully that drilling is done.

The tentative findings were released by researchers with [the Academy of Natural Sciences in Philadelphia](#) on Tuesday to demonstrate the need for studies of the long-term and cumulative impacts of deep-gas drilling on watersheds - an area largely devoid of research despite the rapid expansion of Marcellus Shale gas extraction in the state.

The preliminary study conducted this summer by academy researchers and [a graduate student at the University of Pennsylvania](#) looked at small watersheds in and around Dimock Twp., an epicenter of shale drilling in the region.

Scientists compared water quality and the presence of environmentally sensitive insects and salamanders in nine similar watersheds, three of which had no drilling, three some drilling and three a high density of drilling.

The watersheds with high-density drilling - defined as four to eight wells per square kilometer - had significant impacts on all measures compared to those with little or no drilling, the researchers found.

Water conductivity - a measure of the dissolved salts and metals in the stream and a potential indicator of the presence of gas drilling wastewater - was almost twice as high in the streams in high-density areas than those in areas with little or no drilling.

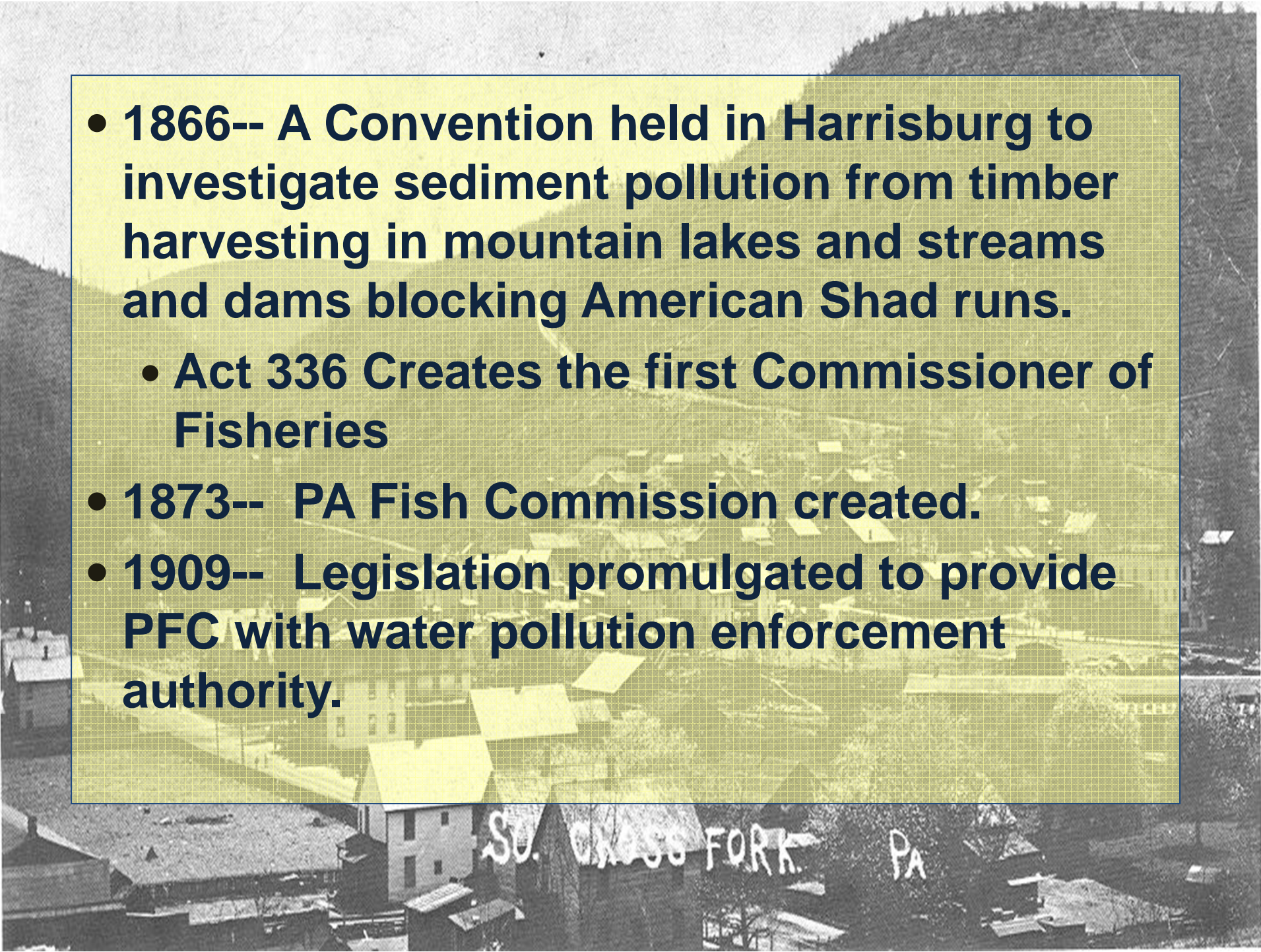
In the high-density sites, the number of both sensitive insects and salamanders were reduced by 25 percent.

The findings were first reported Tuesday by The Philadelphia Inquirer.



What Are PFBC's Responsibilities?



- 
- An aerial photograph of a town, likely South Fork, PA, as indicated by the text at the bottom. The town is nestled in a valley with hills in the background. A yellow semi-transparent box with a blue border is overlaid on the upper portion of the image, containing a list of historical events. The text in the box is in a bold, black, sans-serif font.
- **1866-- A Convention held in Harrisburg to investigate sediment pollution from timber harvesting in mountain lakes and streams and dams blocking American Shad runs.**
 - **Act 336 Creates the first Commissioner of Fisheries**
 - **1873-- PA Fish Commission created.**
 - **1909-- Legislation promulgated to provide PFC with water pollution enforcement authority.**

SOUTH FORK PA

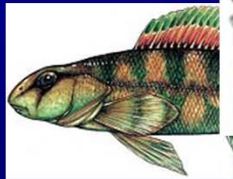
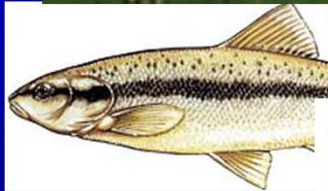
PFBC's Mission



Mission: *To protect, conserve, and enhance the Commonwealth's aquatic resources and provide fishing and boating opportunities.*



PFBC jurisdictional species include:



Duckweed



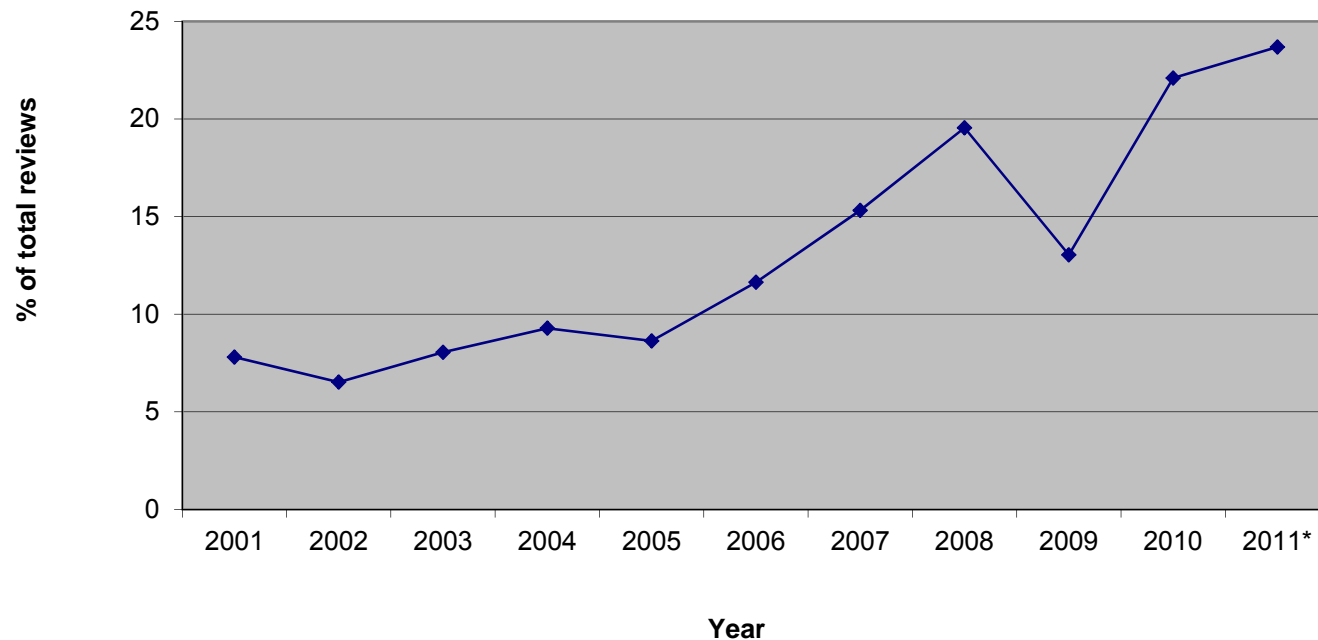
Division of Environmental Services

- Since May 2009
 - 200 site visits and complaints
 - Some require over 12 days for follow-up
 - Training sessions
- 2010 Permit Reviews
 - Waterway encroachments – 20
 - Species of special concern (PNDI) – 555
 - Water withdrawals – 9
- 2011 year to date
 - Waterway encroachment – 76
 - Species of special concern (PNDI) - 234



PFBC PNDI Reviews

Percent of total Oil & Gas Reviews
Species Impact Reviews 2001-2010



Chapter 105 Waterway Encroachments

- 1 Permit Review \neq 1 Encroachment
- 1 Project might cover 4 counties and include 300 individual encroachments
- PFBC reviews all of that



Bureau of Law Enforcement

- 2010
 - Incidents Investigated – 21
 - Settled – 10
 - Pending – 6
 - \$55,250
- 2011 year to date
 - Incidents Investigated – 21
 - Settled – 7
 - Pending – 13
 - \$212,375



Section 2504. Pollution of Waters.



Pollution Enforcement



Section 2502. Disturbance of Waterways and Watersheds.



Pollution Enforcement



Dunkard Creek Aquatic Life Kill



Endangered

September 2009



Summary of Estimates

Taxa Killed – Angler Use Loss	2009 Estimate	Future Loss Estimate
Fish	42,997	99,507
Mussels	15,323	145,569
Endangered Mussel	59	561
Mudpuppies	6,447	61,247
Angler Use Loss (lost trips)	1,455	15,299



An Ounce of
Prevention is Worth a
Pound of Cure!



Unassessed Waters Initiative

by Deborah Weisberg

Biologists from the Pennsylvania Fish & Boat Commission (PFBC) will be venturing to remote streams again this year in search of wild trout, one of the Commonwealth's most precious natural resources.

Partnering with colleges and conservation groups, PFBC personnel will visit headwater tributaries they have never before assessed to determine which merit the greatest protection against Marcellus shale natural gas drilling and other impacts. It's a labor-intensive challenge, given there are 45,000 waterways in Pennsylvania, a state second only to Alaska in sheer number of stream miles. PFBC has scientific data on only 3,000 streams; the rest are unnamed lines on a map known only, perhaps, to a handful of local anglers.

The unassessed waters initiative was officially launched in 2010 as part of the PFBC's five-year strategic trout management plan, but the groundwork was laid in 2006. Initially, the goal was to document streams in wild trout watersheds

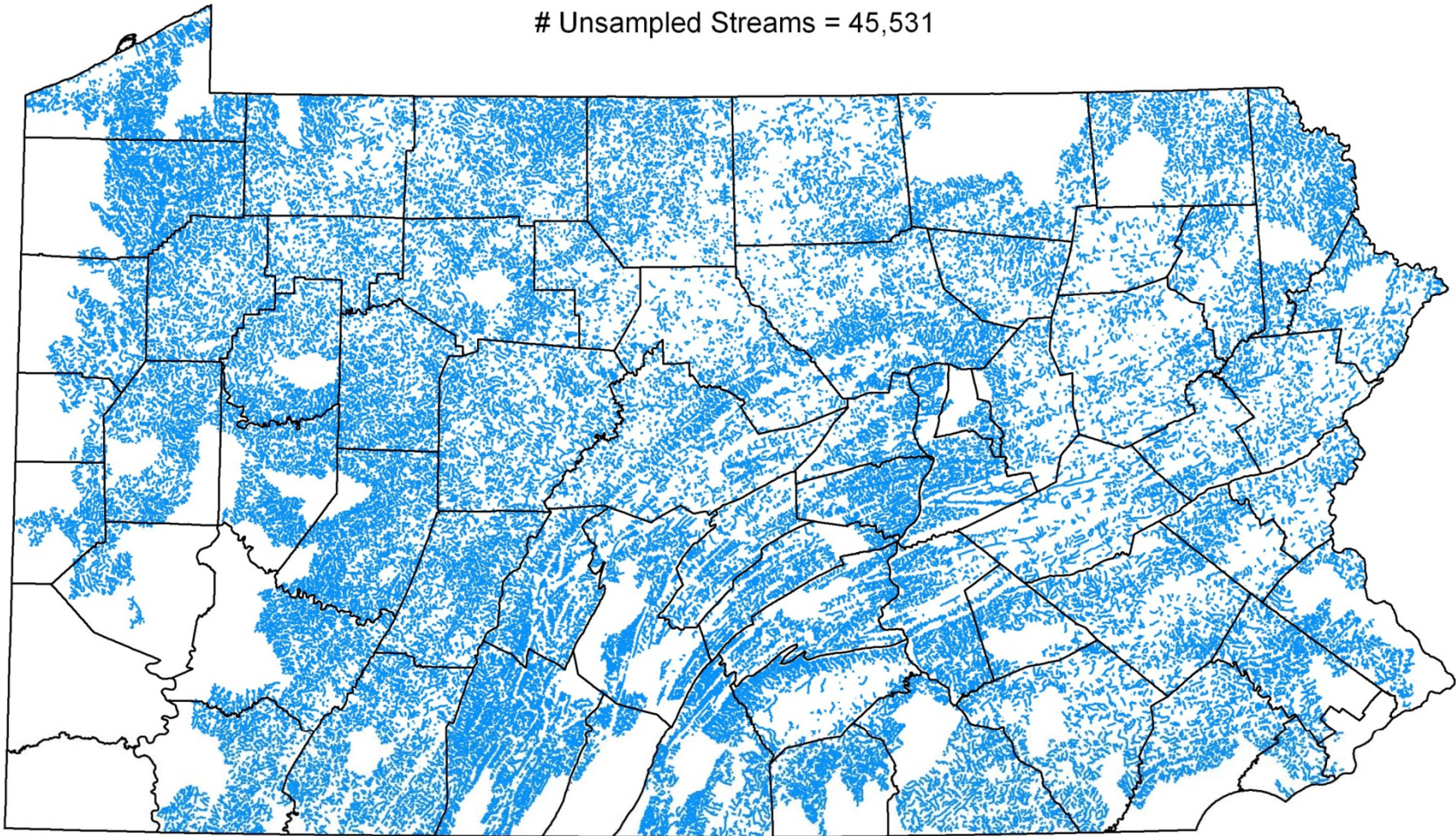
with increasing human encroachment. However, the boon in natural gas extraction has given the task new urgency, according to PFBC fisheries biologist Bob Weber, who is coordinating the project. "We used Geographic Information System technology to map wild streams we currently know about. Then, we layered those with human population data from the United States Census, because that tells us where development is occurring," he said. "We later layered in where Marcellus drilling operations have been permitted or where they are likely to be."

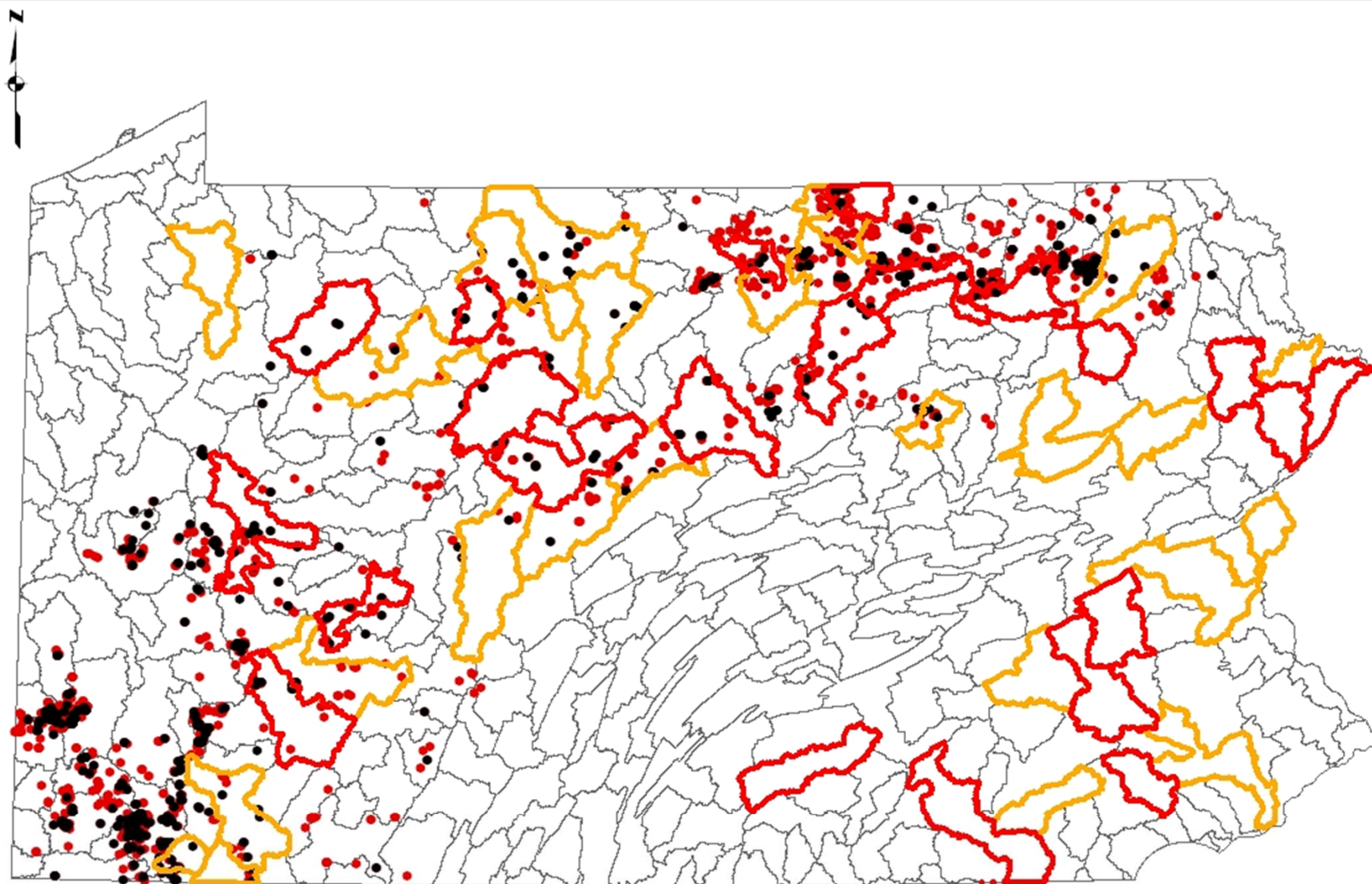
Since 2005, the Pennsylvania Department of Environmental Protection (DEP) has permitted the drilling of 21,075 gas wells. In just the past 22 months, DEP has cited 43 drilling companies for more than 1,435 violations.



Unsamed Streams Within Watersheds With Wild Trout

Unsamed Streams = 45,531





- Final Priority 1
- Final Priority 2
- Active Marcellus Wells
- Permitted Marcellus Wells

Pennsylvania's Oil and Gas Act



Distance Restrictions from Well Pad:

- **100 ft. from a stream, spring or body of water identified on the most current 7 ½ minute USGS topographic map.**
- **100 ft. must be maintained to any wetland greater than one acre in size.**
- **200 ft from an existing building or water well without written consent of the owner.**
- **PA DEP may grant a waiver to the distance restriction.**



PFBC Suggested Changes to Oil and Gas Act

- **Change topographic map reference for well locations**
- **Allow for permits to be conditioned or deny permits based on potential impacts to water and wetlands**
- **Pre-consultation with PFBC for special protection watersheds**
- **SB 425 and HB 971**



Severance Tax & Impact Fees

- LBFC Recommendation
- SB 352 (Dinniman) – 3%
- HB 833 (George) – 3%
- HB 33 (Vitali) – 1.4%
- HB 1406 (Harper) – 1.4%
- Impact Fees



Need to do the Job Right and be Compensated for Our Work

- **Unfair to Ask Anglers and Boaters to Bear the Burden**
- **Need at Least 13 New Staff**
 - Review permits
 - Conduct site reviews
 - Process T&E species impact reviews
 - Additional law enforcement
- **At Least \$1.5-2.0 Million Annually**
- **Model MOUs**



Questions??

