INTRODUCTION TO WATER AND WATER POLICIES

"All the water that will ever be is, right now."

- National Geographic, October 1993

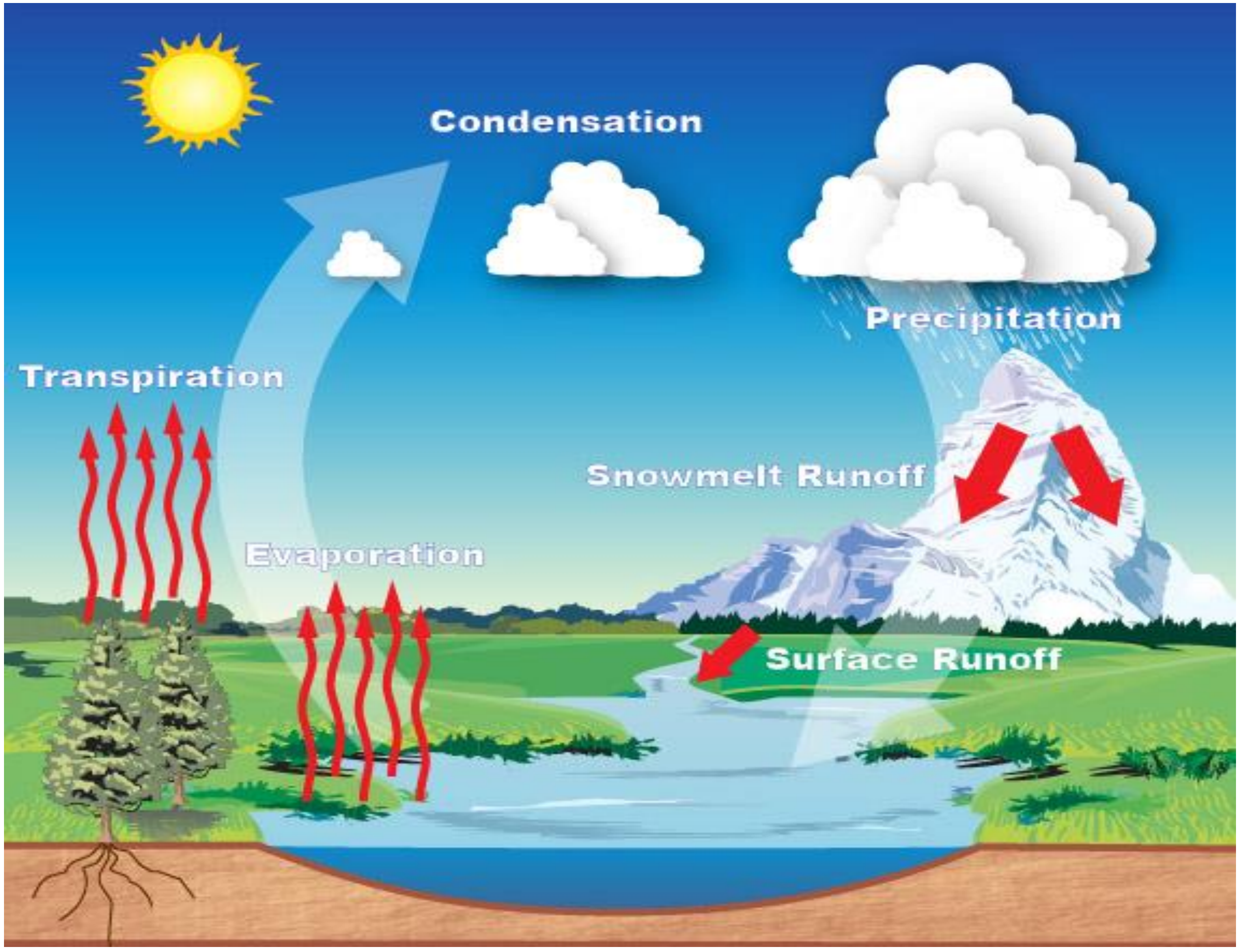
Introduction to Water and Water Policies

- Introduction
  - Hydrologic cycle
  - Pollution sources
- Overview of U.S. Legislation
- State Legislation
- Watershed Legislation
- Economic Incentives
  - Effluent fees on point source
  - Product charges on nonpoint sources
  - Tradable effluent permits

Water Resources and Their Interdependence

- Surface water
  - Bodies of water open to earth's atmosphere as well as springs, wells, or other collectors directly influenced by surface water
- Ground water
  - Fresh water beneath the earth's surface, generally in aquifers
- Linked together by the hydrologic cycle
  - Natural movement of water from the atmosphere to the surface, underground, and back to the atmosphere
  - Explains the ***interdependence*** of water resources

Hydrologic Cycle

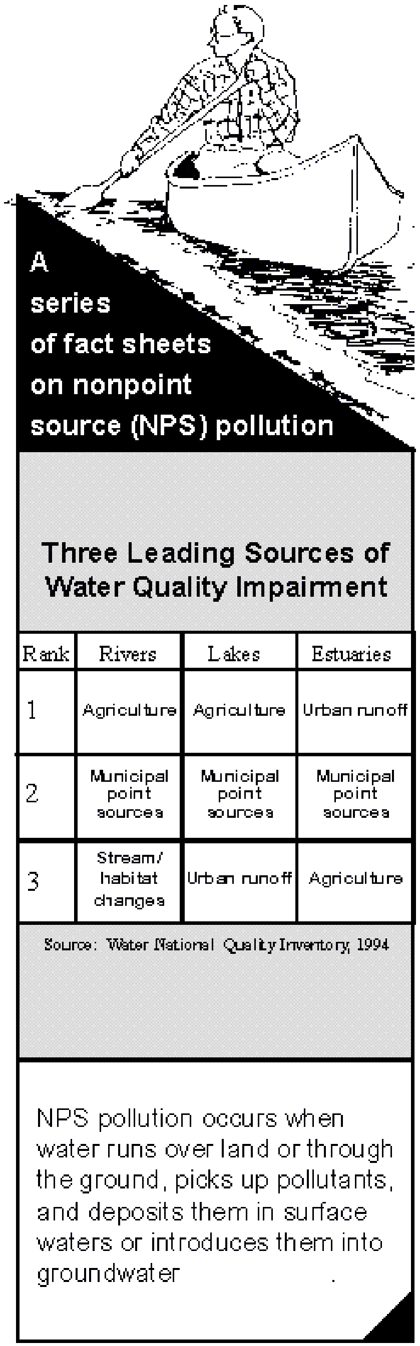


Source: *NOAA, National Weather Service (June 9, 2010).*

Polluting Sources

- Point Source
  - Any single identifiable source from which pollutants are released, such as a factory smokestack, a pipe, or a ship
- Nonpoint Source
  - A source that cannot be identified accurately and degrades the environment in a diffuse, indirect way over a relatively broad area
- Water pollution is a classic example of a market failure
  - Requires corrective action

Water Pollution



A series of fact sheets on nonpoint source (NPS) pollution

Three Leading Sources of Water Quality Impairment

Rank	Rivers	Lakes	Estuaries
1	Agriculture	Agriculture	Urban runoff
2	Municipal point sources	Municipal point sources	Municipal point sources
3	Stream/ habitat changes	Urban runoff	Agriculture

Source: Water National Quality Inventory, 1994

NPS pollution occurs when water runs over land or through the ground, picks up pollutants, and deposits them in surface waters or introduces them into groundwater.

US Spending: Point vs. Nonpoint
($2010 millions)

Program	***1987***	***1995***	***2000***
Point	**$66,932 97.7%**	**$94,106 98.1%**	**$112,618 98.3%**
Nonpoint	**$1,551 2.3%**	**$1,776 1.9%**	**$1,908 1.7%**

Source: *U.S. EPA, Office of Policy, Planning, and Evaluation (December 1990), p. 3-3, Table 3-3.*

Water Pollutants Under the Law

- Toxic pollutants
  - upon exposure will cause death, disease, abnormalities, etc.
- Conventional pollutants
  - identified and well understood by scientists
- Non-conventional pollutants
  - default category

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Overview of US Legislation

- Similar to U.S. air quality laws, there was no federal legislation dealing with water pollution until 1948
  - Even then, federal responsibility was limited
- In the 1970s, landmark legislation was passed, the Federal Water Pollution Control Act of 1972
  - Guides much of today's policy
  - Main responsibility for water quality shifted to the federal level
  - Specific goals for water quality were established
  - New technology-based effluent limitations were set

Federal Policy Goals
(from FWPCA of 1972)

- Zero discharge goal
  - Eliminate release of all effluents by 1985
  - Overly ambitious
  - Inefficient because it is benefit-based
  - Unsatisfactory track record
  - EPA was to tighten the standards toward a zero limit, but this has occurred rarely
- Fishable-swimmable goal
  - Interim goal to achieve swimmable-fishable quality, allow for recreational use by 1983
- No toxics in toxic amounts
  - Prohibit release of toxic pollutants in toxic amounts

Overview of US Legislation

- Clean Water Act (CWA) of 1977 extended compliance deadlines and strengthened the law on toxic pollutants

BCA of CWA of 1977

- Carson and Mitchell (1993) use the CVM approach to estimate the value of water quality improvements associated with U.S. regulations.
- Carson and Mitchell (1993) and EPA estimated costs of CWA of 1977

Total Social Benefits

- Based on contingent valuation method (CVM)
  - Recall CVM *can* account for existence value
- **TSB_{1990} = $46.7 billion** ($1990)
  - Represents the value of improving water quality from nonboatable up to swimmable

Total Social Costs

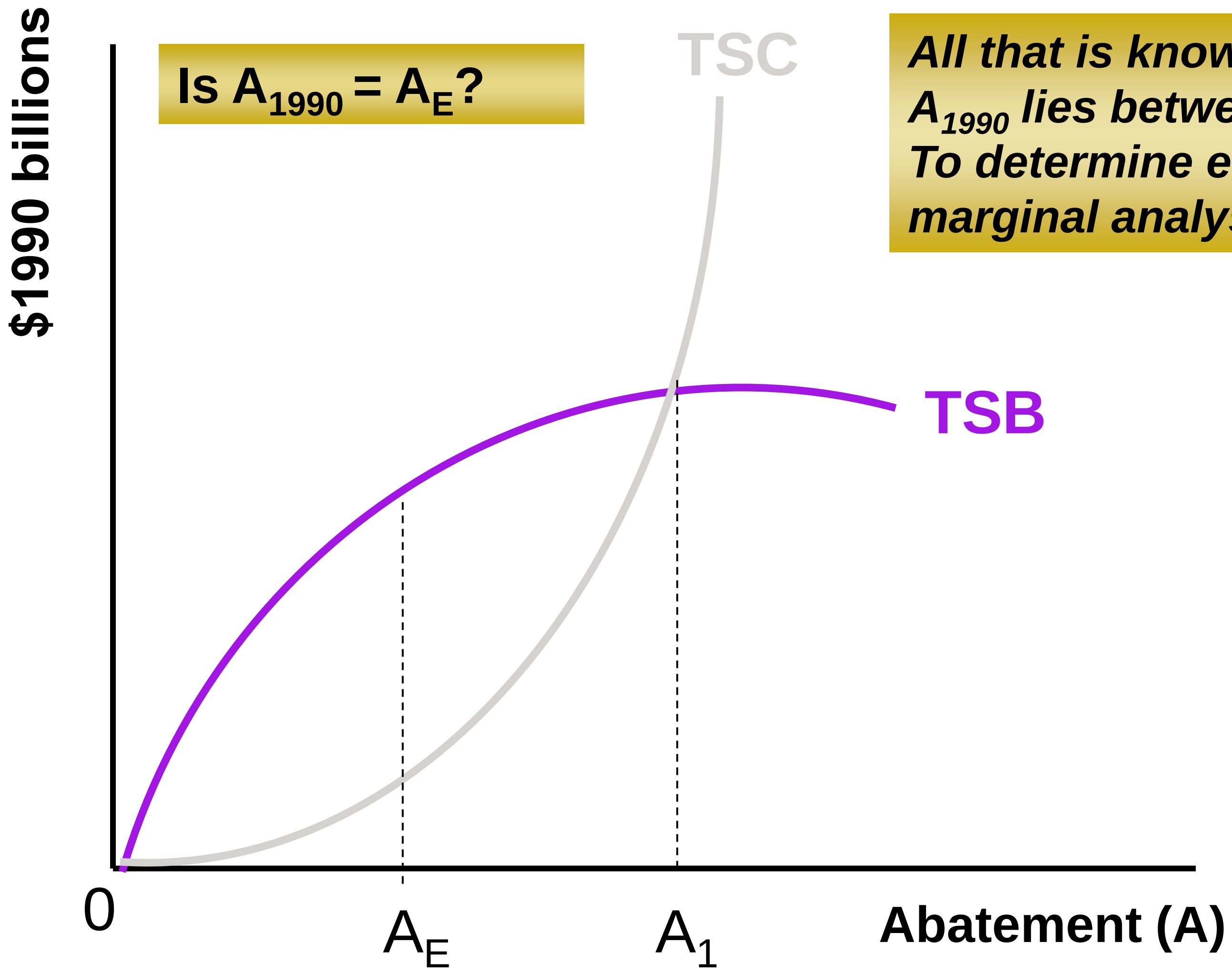
- Average two estimates
  - TSC_{1988} = \$37.3B (\$1990)
    - Dept of Commerce data used by Carson & Mitchell
  - TSC_{1990} = \$50.6B (\$1990)
    - EPA projected data
- **TSC_{1990} = \$44.0B** (\$1990)

Benefit-Cost Comparison

- Result: **TSB of $46.7 B > TSC of $44.0 B**
  - So net benefit is positive
- Question: Is allocative efficiency achieved?
  - Consider the following graph

Benefit-Cost Comparison

post-1972 policy



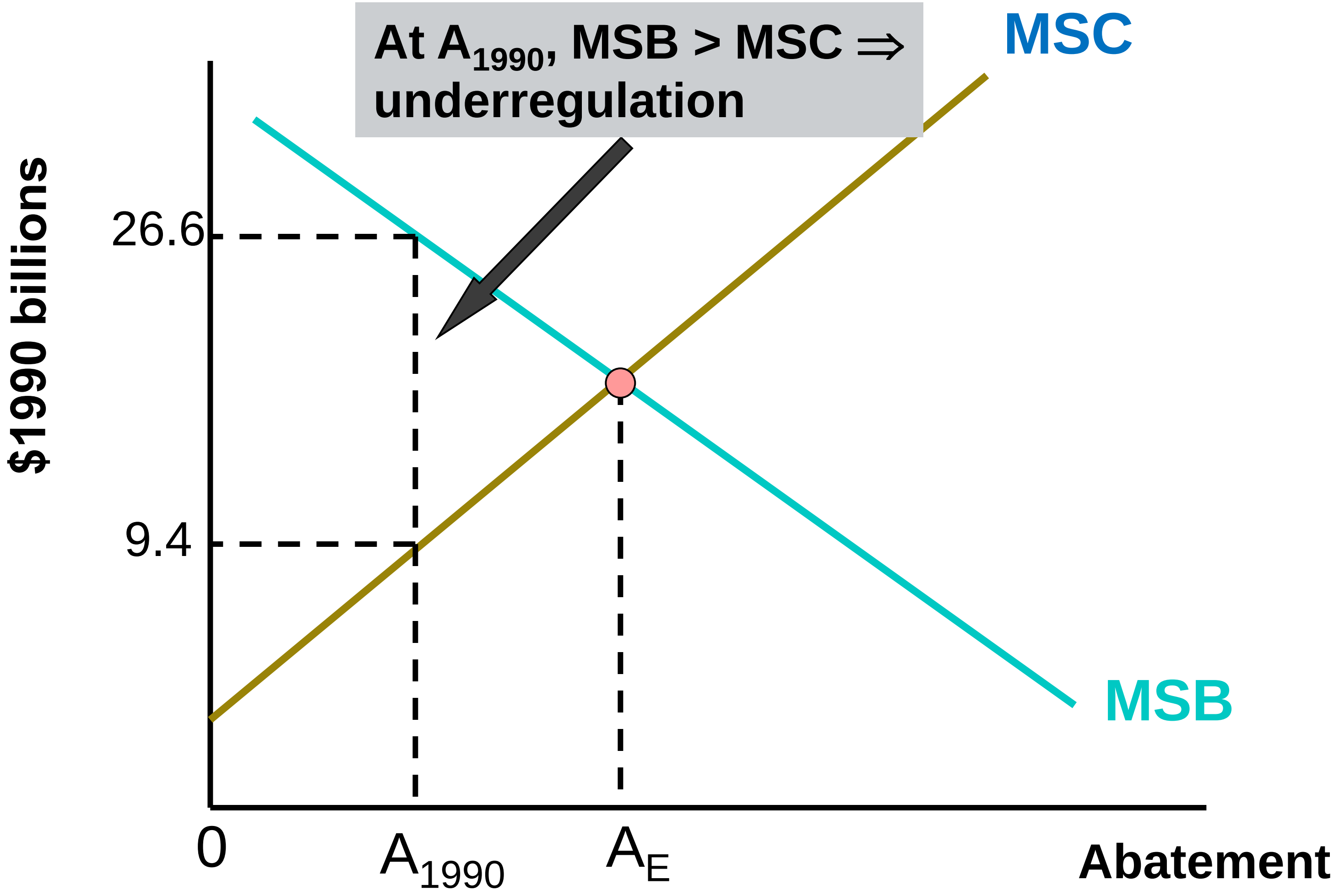
All that is known is that A_{1990} lies between 0 and A_1. To determine efficiency, need marginal analysis

Marginal Analysis

- Approximated with incrementals using Freeman's (1982) earlier estimates for 1985
- $MSC_{1990} = TSC_{1990} – TSC_{1985}$
  $= \$44.0B – 34.6B = \$9.4B$ (\$1990)
- $MSB_{1990} = TSB_{1990} – TSB_{1985}$
  $= \$46.7B – 20.1B = \$26.6B$ (\$1990)
- Since MSB > MSC…
  - abatement levels are not efficient
  - water quality control is likely ***underregulated***

Benefit Cost Comparison

post-1972 policy



Deepwater Horizon Oil Spill
Benefits and Costs

- Explicit costs to BP estimated to be $41 billion
- Benefits from abatement include:
  - Natural resources damages
    - oiled wildlife, impairment to marine life
  - Economic effects
    - Damage to seafood, tourism, oil, and gas industries
  - Human losses
    - Loss of lives and injuries from explosion
    - Risks to physical and emotional health of residents

Problems for Benefit-Cost Analysis of Water-Quality Improvements

- Identifying the water-quality change to be valued
  - First, a BCA must identify what changes would have taken place over this time without this measurement in place
  - Second, impacts of a program of measures on water quality will be uncertain
- Valuing the water-quality change, once identified
  - Difference between how water quality is measured by scientists and regulators and how it is perceived by ordinary people
  - Per-person or per-trip measurement versus ‘how many people benefit’?

Current U.S. Legislation

- Water Quality Act of 1987 governs policy today
  - Required states to set up programs for nonpoint sources
  - Replaced a federal grant program for POTWs with a state loan program
- Other Water Quality Legislation (examples)
  - 1988 Ocean Dumping Ban Act
  - 1990 Oil Pollution Act of 1990
  - 2000 Beaches Environmental Assessment and Coastal Health (BEACH)
  - 2002 Great Lakes Legacy Act

Recent Executive Orders Relating to Water Quality

- **Executive Order 13508**: *Chesapeake Bay Protection and Restoration*, May 12, 2009
- **Executive Order 13543:** *National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling*, May 22, 2010.
- **Executive Order 13547:** *Stewardship of the Ocean, Our Coasts, and the Great Lakes,* July 19, 2010**.**
- **Executive Order 13554:** *Gulf Coast Ecosystem Restoration Task Force*, October 5, 2010

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Standards to Define Water Quality

Receiving Water Quality Standards (from 1965 law)

- Set by states for each water body
- Two components
  1. Use designation: intended purpose of water body
     - At minimum must meet swimmable-fishable standard
  2. Water quality criteria: biological and chemical attributes to sustain or achieve use designation
     - These are pollutant specific

Absence of Benefit-Cost Analysis

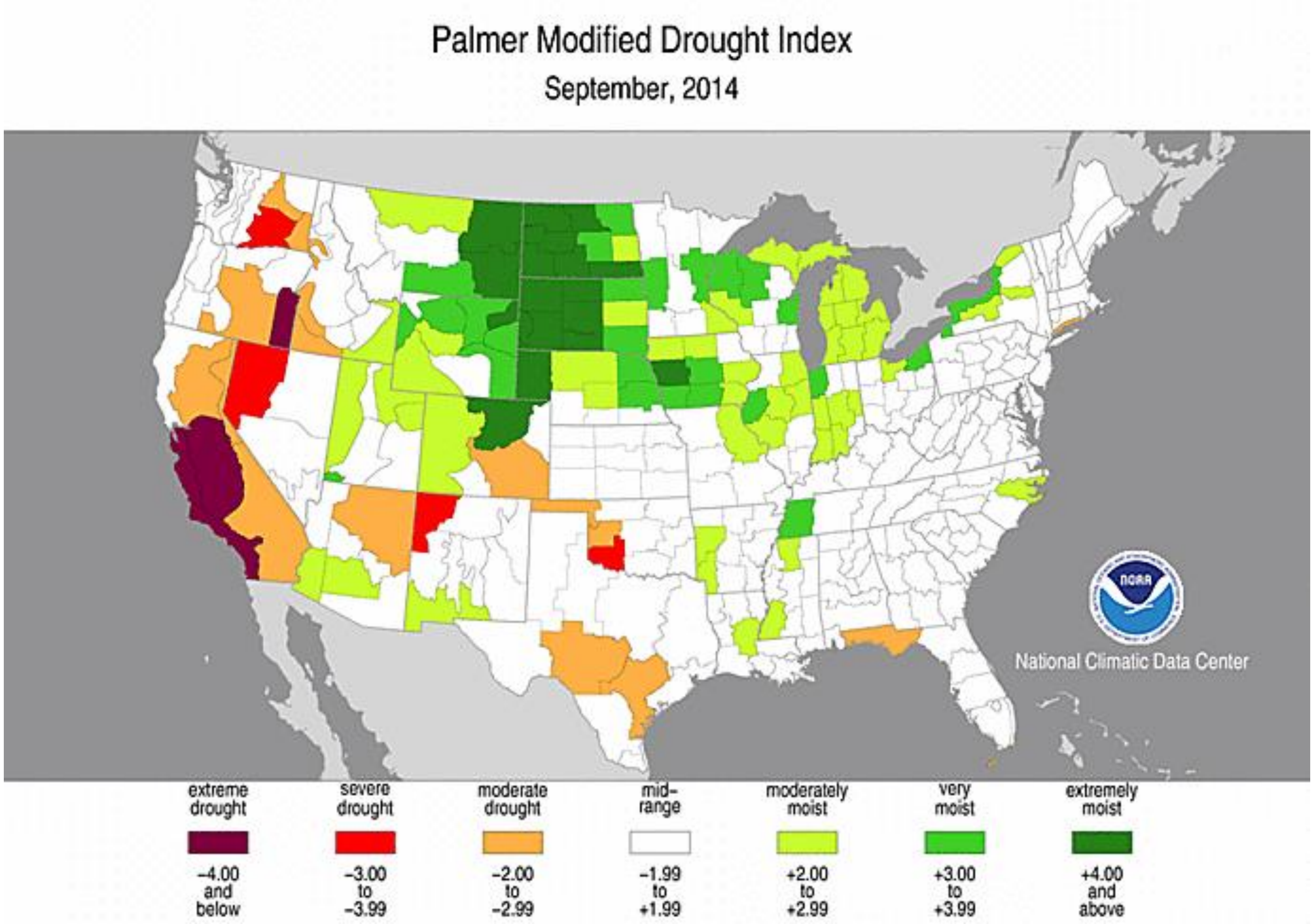
- States could use benefit-cost analysis in setting the receiving water quality standards, but they were not required by law to do so
- Use designation had to be consistent with national goals, meaning at minimum achieving swimmable-fishable quality, a goal that is solely ***benefit-based***
- Therefore, no assurance that efficiency is achieved

New Mexico

- New Mexico water is administered by a doctrine of Prior Appropriation
  - "First in time, first in right."
- Several factors compromise the pioneering water legislation that guided New Mexico water management through the 20th century
  - Population size
  - Drought
  - Federal claims for stream flows for endan
  - Inter-state compacts for water delivery

- Average annual precipitation is 14"
  - Most in-flow comes from snowmelt in Northern NM and CO
- New Mexico is one of the first western states to have a Drought Management Plan

NM Drought


Palmer Modified Drought Index
September, 2014
National Climatic Data Center
extreme drought
-4.00 and below
severe drought
-3.00 to -3.99
moderate drought
-2.00 to -2.99
mid-range
-1.99 to +1.99
moderately moist
+2.00 to +2.99
very moist
+3.00 to +3.99
extremely moist
+4.00 and above

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Watershed Approach

- A watershed refers to all land areas draining into a particular water body
- Focusing on the watershed instead of a specific water body allows for
  - better assessment of water quality
  - better identification of polluting sources
- Underlying motivations are:
  - to integrate policy initiatives, using pollution prevention where possible
  - To coordinate tasks and resource use among all stakeholders

Watershed Funding in the US

- Some federal grants are earmarked for watershed projects
- Targeted Watershed Grants Program was launched in 2002
  - Since 2003, has funded 61 organizations with over $50 million in grants
    - Torreon Wash, NM

Colorado River Basin

- John Fleck

Rio Grande River Basin

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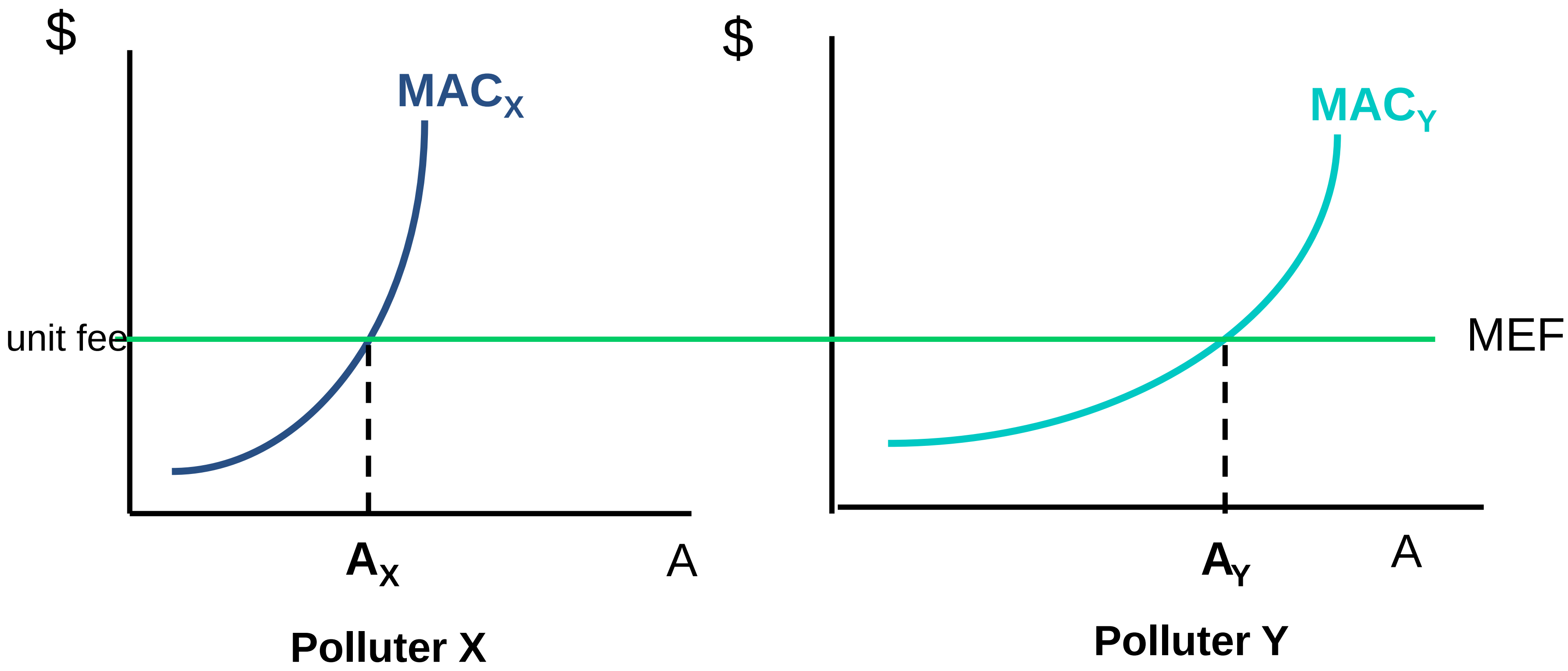
Effluent Fees

- These can be volume-based or pollutant-based
- Real-world usage
  - Some states in the U.S. are using these fees as well as other nations, including France, Germany, Malaysia, and China
- Usage can lead to cost-effectiveness
  - If government sets a per-unit marginal effluent fee (MEF), each polluter would abate as long as their marginal abatement cost (MAC) is less than MEF and continue until MAC = MEF
  - So all polluters abate to the point where their MACs are equal, which indicates a cost-effective result

Modeling an Effluent Fee



Notice that both firms are abating at levels where their respective MACs are equal to the MEF, which means they are equal to each other – a cost-effective result.

Are the Effluent Fees Efficient?

- Combined abatement level reached by both polluters would not be **efficient** unless the MSB of abatement were equal to the associated MSC
  - Even if MSB and MSC could be determined (which would be difficult in practice), result would be efficient *only* in the aggregate, and not at each site unless the MSB and MSC at each site were identical – highly unlikely
- For example, consider two pollution sites – a low population and a high population site, with differing MSB. What is the outcome if both face a single, national effluent fee?

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Product Charge

Example: Tax on fertilizers

- Tax $\Rightarrow$ effective $P_{fertilizer} \uparrow \Rightarrow Q_D \downarrow$
  - Optimal tax equals MEC at Q_E
- Issue is *degree* of response of Qd
- Anecdotal evidence in the U.S. suggests D for fertilizer is relatively *inelastic* and tax rate is too low
  - Result: insufficient Qd response
    - 46 states use this; rates tend to be < 2.5%, so the decline in Q_D is negligible
- Some European nations, such as Austria and Sweden, have used fertilizer taxes with measurable effects

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Tradeable Effluent Permit Markets

- Set an abatement objective for watershed and issue tradeable effluent permits
  - Low-cost abaters sell as long as P > their MAC
  - High-cost abaters buy as long as P < their MAC
  - Trading continues until MACs equal, yielding a cost-effective abatement allocation
- Markets involving both point and nonpoint sources exist in some states and other countries
  - e.g., CA, CO, NJ, WI; Australia, Canada

Primary U.S. Policy Instruments

- Watershed-based National Pollutant Discharge Elimination System (NPDES) permits issued to multiple point sources within a watershed
- Water quality trading
  - U.S. policy explicitly states that all trading activity should occur within a watershed
  - Supported by economic arguments, including cost savings, scale economies, and greater efficiency