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Water Quality Trading

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Water Quality Information Center

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1. **Agricultural and water-quality conflicts: Economic dimensions of the problem.**
   Crutchfield, Stephen R., Hansen, LeRoy T., Ribaudo, Marc., and United States. Dept. of Agriculture. Economic Research Service.
   Washington, DC: U.S. Dept. of Agriculture, Economic Research Service, [1993] 18 p.: ill., maps: Caption title. "July 1993." "Water quality." Includes bibliographical references (p. 18).
   NAL Call #: 1-Ag84Ab-no.676
   Descriptors: Water-quality-Economic-aspects-United-States; Groundwater-Pollution-Economic-aspects-United-States; Agricultural-chemicals-Environmental-aspects-United-States; Agriculture-and-state-United-States

2. **Agricultural nonpoint source pollution and economic incentive policies: Issues in the reauthorization of the Clean Water Act: Water quality.**
   Malik, Arun S., Larson, Bruce A., Ribaudo, Marc., and United States. Dept. of Agriculture. Economic Research Service. Resources and Technology Division.
   Washington, DC: U.S. Dept. of Agriculture, Economic Research Service, Resources and Technology Division, [1992] iv, 14 p.: Cover title. "November 1992"--P. iii. Includes bibliographical references (p. 12-14).
   NAL Call #: aTD428.A37M34-1992
   Descriptors: Agricultural-pollution-Government-policy-United-States; Water-Pollution-Government-policy-United-States

3. **Albemarle-Pamlico: Case study in pollutant trading. Most of the nutrients came from nonpoint sources.**
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   Willey, Z.
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   ISSN: 0002-1458.
   Descriptors: Agricultural management; Economic analysis; Nonpoint source pollution; Water pollution; Water quality; Environmental fate

5. **The bioeconomics of regulating nitrates in groundwater from agricultural production through taxes, quantity restrictions, and pollution permits.**
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   Ithaca, N.Y.: Dept. of Agricultural, Resource, and Managerial Economics, College of Agricultural and Life Sciences, Cornell University, [1995] 97 p.: ill.: Cover title. "November 1995." Includes bibliographical references (p. 76-83).
   NAL Call #: HD1751.R25--no.95-06
   Descriptors: Nitrates-Environmental-aspects; Nitrogen-fertilizers-Environmental-aspects; Nitrogen-fertilizers-Control-Economic-aspects; Groundwater-Pollution-Economic-aspects

6. **Building markets for tradable pollution rights: Ohio River Valley Water Sanitation Commission (ORANSCO), Federal Water Pollution Control Act of 1972.**
   Maloney, M. T. and Yandle, B.
   In Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment. Editor: T.L. Anderson. San Francisco, Calif.: Pacific Institute for Public Policy Research. pp.

283-320.
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7. **Can a watershed be managed?**
Johnson, C. R., Kaunelis, V. P., and Cave, K. A.
Water Environment and Technology. 12 (6): 31-33. (2000).
NAL Call #: TD419.W37
ISSN: 1044-9493.
Descriptors: Catchment hydrology; Nonpoing source pollution; Watersheds; Michigan

8. **Charting a new course: Pollutant trading can play a key role in improving water quality.**
Podar, Mahesh and Kashmanian, Richard M.
Forum for Applied Research and Public Policy. 13: 40-44 (Fall 1998).
ISSN: 0887-8218.
Descriptors: Environmental policy; Economics; Water pollution; Pollution control; Water quality; United States

9. **Chesapeake nutrient trading needs CWA funding.**
Water Environment and Technology. 7 (5): 30-34. (1995).
NAL Call #: TD419.W37
ISSN: 1044-9493.
Descriptors: Environmental programs; Clean Water Act; Chesapeake Bay; Water quality

10. **A classroom experiment about tradable permits.**
Kilkenny, M.
Review of Agricultural Economics. 22 (2): 586-606 (Fall/Winter 2000).
NAL Call #: HD1773.A3N6
ISSN: 1058-7195.
Descriptors: rural-communities; permits; experiments; teaching-methods; externalities; costs; college-students; markets

11. **Controlled trading of pollution permits.**
Russell, C. S.
Environmental Science and Technology. (Washington, D.C.: American Chemical Society) 15 (1): 24-28 (Jan 1981).
NAL Call #: TD420.A1E5
ISSN: 0013-936X.

12. **Cost-effective point-nonpoint trading: An application to the Susquehanna River Basin**
Horan, R. D., Abler, D. G., Shortle, J. S., and Carmichael, J.
Journal of the American Water Resources Association. 38 (2): 467 (2002).
NAL Call #: GB651.W315
ISSN: 1093-474X.

Descriptors: Nonpoint source pollution; Water quality; Environmental programs; Cost benefit analysis; Watersheds; Pennsylvania

13. **Cost minimization of nutrient reduction in watershed management using linear programming.**
Schleich, J. and White, D.
Journal of the American Water Resources Association. 33 (1): 135-142 (Feb 1997).
NAL Call #: GB651.W315
ISSN: 1093-474X.
Descriptors: watershed-management; water-quality; nutrients; pollutants; phosphorus; linear-programming; cost-effectiveness-analysis; cost-control; wisconsin; suspended-solids
Abstract: Linear programming is applied to identify the least cost strategy for reaching politically specified phosphorus and total suspended solids reduction targets for the Fox-Wolf river basin in Northeast Wisconsin. The programming model uses data collected on annualized unit reduction costs associated with five categories of sources of phosphorus and total suspended solids discharge in each of the 41 subwatersheds in the basin to determine the least cost management strategy. Results indicate that: (1) cost-effective nutrient reduction requires careful selection of geographic areas and source categories to address throughout the watershed; (2) agricultural sources are the most cost-effective to address in the basin; and (3) care should be exercised in setting nutrient reduction targets, given that there are likely to be significantly increasing marginal costs of nutrient reduction; the model predicts that lowering the most restrictive target by 33 percent would cut reduction expenditures by about 75 percent. Policy implications of the model include support for the investigation and potential development of institutional arrangements that enable cost-effective nutrient reduction activities to occur, such as the creation of an agency with authority over a given watershed, coordinated watershed management activities, or nutrient trading programs.

14. **Design and Legality of an Innovative Approach to Nonpoint Source Control.**
Dudek, D. and Wendel, H.
Contributed Papers and Abstracts for the Conference on Water, Laws and Management: September 17-22, 1989, Tampa, Florida. (1989).
NAL Call #: TD223.A1C66
Descriptors: Nonpoint source pollution; Water pollution; Water quality; Environmental programs; Colorado

15. **Differences in social and public risk perceptions and conflicting impacts on point/nonpoint trading ratios.**
Horan, R. D.
American Journal of Agricultural Economics. 83 (4): 934-941 (Nov 2001).
NAL Call #: 280.8-J822
ISSN: 0002-9092.
Descriptors: water-quality; pollution-control; risk; social-costs; ratios; stochastic-processes; federal-programs; equations; United States
Abstract: If stochastic nonpoint pollution loads create socially costly risk, then an economically optimal point/nonpoint trading ratio-the rate point source controls trade for

nonpoint controls-is adjusted downward (a risk reward for nonpoint controls), encouraging more nonpoint controls. However, in actual trading programs, ratios are adjusted upward in response to nonpoint uncertainties (a risk premium for nonpoint controls). This contradiction is explained using a public choice model in which regulators focus on encouraging abatement instead of reducing damages. The result is a divergence of public and social risk perceptions, and a trading market that encourages economically suboptimal nonpoint controls.

16. **Draft framework for watershed-based trading.**
Environmental Protection Agency, Washington D. C. USA Office of Water.
Washington, D.C.: U.S. Environmental Protection Agency, 1996. EPA/800-R-96-001.
URL: http://www.epa.gov/owow/watershed/trading/framwork.html
Descriptors: Watersheds; Water quality; Environmental programs; Clean Water Act

17. **Economic and environmental modelling for pollution control in an estuary.**
Hanley, N., Faichney, R., Munro, A., and Shortle, J. S.
Journal of Environmental Management. 52 (3): 211-225 (Mar 1998).
NAL Call #: HC75.E5J6
ISSN: 0301-4797.
Descriptors: estuaries; water-pollution; pollution-control; water-quality; permits; oxygen-requirement; case-studies; uncertainty; probabilistic-models; scotland; tradable-pollution-permits; forth-estuary; scotland; emissions; emissions-permit-system; ambient-permits-system

18. **Economic incentives for agricultural nonpoint source pollution control.**
Malik, A. S., Larson, B. A., and Ribaudo, M.
Water Resources Bulletin. 30 (3): 471-480 (May/June 1994).
NAL Call #: 292.9-Am34
ISSN: 0043-1370.
Descriptors: water-pollution; pollution-control; environmental-legislation; incentives; economic-policy; Clean-Water-Act
Abstract: The limited success of command-and-control policies for reducing nonpoint source (NPS) water pollution mandated under the Federal Water Pollution Control Act (FWPCA) has prompted increased interest in economic incentive policies as an alternative control mechanism. A variety of measures have been proposed ranging from fairly minor modifications of existing policies to substantial revisions including watershed-wide polices that rely on economic incentives. While greater use of economic incentive policies, such as environmental bonds and point/nonpoint source trading is being advocated in the reauthorization of the CWA, the expected effects of individual proposals will be modest. The characteristics of NPS pollution, namely uncertainty and asymmetrical information, underscores that there is no single, ideal policy instrument for controlling the many types of agricultural NPS water pollution. Some of the usual incentive-based policies, such as effluent taxes, are not well suited to the task. Individual incentive policies proposed for the reauthorized CWA, such as pollution trading or deposit/refund systems, are not broadly applicable for heterogeneous pollution situations. Economic incentive policies may be appropriate in some cases, and command-and-

control policies will be preferable in others and may in fact complement incentive policies.

19. **Economics of water quality protection from nonpoint sources: Theory and practice.**
Ribaudo, Marc., Horan, Richard D., Smith, Mark E. Mark Eugene 1957, and United States. Dept. of Agriculture. Economic Research Service.
Washington, DC: U.S. Dept. of Agriculture, Economic Research Service, [1999]. 106 p.: ill., col. maps: Cover title. "November 1999"--P. [i]. Includes bibliographical references (p. 96-106).
NAL Call #: A281.9-Ag8A-no.-782; SUDOCS: A 1.107:782.
URL: http://www.ers.usda.gov/publications/AER782/
Descriptors: Water-quality-United-States; Nonpoint-source-pollution-United-States; Agricultural-pollution-United-States; Water-Pollution-Economic-aspects-United-States

20. **Efficiency of U.S. conservation-compliance program.**
Govindasamy, R. and Huffman, W.
Agricultural Economics. 8 (2): 173-185 (Feb 1993).
NAL Call #: HD1401.A47
ISSN: 0169-5150.
Descriptors: erosion; control; erosion-control; soil-conservation; federal-programs; opportunity-costs; losses-from-soil; equations; production-costs; profits; soil-types; mathematical-models; efficiency; United-States; Iowa; cost-functions
Abstract: Under the conservation-compliance program, most of the individual producers are forced to cut their soil erosion to 7 t per acre annually irrespective of the marginal cost of controlling soil erosion. In a system where coupons to a ton of soil loss were issued to producers and traded, the marginal cost of controlling soil loss within each soil type and across different soil types would be equalized. An instrumental variable procedure was used to determine the effect of soil erosion on net profits. The results for Iowa show that there is considerable difference in the marginal opportunity cost of controlling soil erosion between soil types. By assigning one ton of erosion to Iowa soil type Downs (5-10% slope) instead of Clarion (2-5% slope), there is a savings of $5.00 per acre for the society as a whole. The tradable coupon system is not only efficient, but will also bring in more land under soil conservation.

21. **Estuarine Management from a Global Economic Perspective.**
Bundy, M. M.
Water Science and Technology. 26 (12): 2735-2739 (1992).
NAL Call #: TD420.A1P7
Descriptors: Estuaries; Water quality; Environmental programs; Watersheds; Chesapeake Bay

22. **Feasibility of point-nonpoint source trading for managing agricultural pollutant loadings to coastal waters.**
Crutchfield, S. R., Letson, D., and Malik, A. S.
Water Resources Research. 30 (10): 2825-2836 (Oct 1994).
NAL Call #: 292.8-W295
ISSN: 0043-1397.

Descriptors: pollutants; agriculture; water-pollution; point-sources; pollution-control; water-quality; watersheds; coastal-areas; feasibility; United-States; nonpoint-source-pollution; point-source-pollution
Abstract: A recent focus of water quality policy discussions has been the trading of pollution abatement between point and nonpoint sources. Point-nonpoint trading would allow point sources to sponsor nonpoint source controls rather than install further controls of their own. If nonpoint source loadings are significant and the marginal costs of their control are lower than for additional point source controls, water quality goals could be met at lower cost with trading. We isolate difficulties particular to incentive policies such as point-nonpoint trading and then screen coastal watersheds for those satisfying conditions that play a major role in determining whether trading can improve water quality. We follow the recent Coastal Zone Act Reauthorization Amendments in emphasizing agriculture, the single largest cause of nonpoint source pollution. Our screening analysis provides an initial, empirical assessment of the feasibility of trading for managing agricultural land use to protect coastal water quality. We also illustrate the additional analysis required to quantify the potential for successful trading in those watersheds which meet our screening criteria.

23. **Fertile ground: Nutrient trading's potential to cost-effectively improve water quality.**
Faeth, Paul.
Washington, DC: World Resources Institute, 2000. 50 p.: ill., map:Includes bibliographical references (p. 47-50).
NAL Call #: TD427.N87-F33-2000
URL: http://pubs.wri.org/pubs_description.cfm?PubID=2690
Descriptors: Nutrient-pollution-of-water-United-States; Water-quality-management-United-States

24. **Furthering 'beyond-compliance' programs.**
Linett, B., Hartig, J. H., Wise, P. L., Mehan, G. T., Tosine, H. M., and Gulezian, G.
Water Environment and Technology. 10 (11): 63-68 (1998).
NAL Call #: TD419.W37
ISSN: 1044-9493.
Descriptors: Evironmental programs; Water quality; Water pollution; Pollution prevention; Great Lakes

25. **Green evolution: are economic incentives the next step in nonpoint source pollution control?**
Young, T. F. and Karkoski, J.
Water Policy. 2 (3): 151-173. (2000).
ISSN: 1366-7017.
Descriptors: Pollution control; Environmental policy; Economics; Nonpoint source pollution; Runoff; Best management practices

26. **Green payments for nonpoint pollution control.**
Horan, R. D., Shortle, J. S., and Abler, D. G.
American Journal of Agricultural Economics. 81 (5): 1210-1215 (1999).

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Descriptors: pollution-control; incentives; federal-programs; support-measures; environmental-protection; water-quality; United-States; Clean-Water-Action-Plan

27. **Has the time come to regulate farmers: We already do, but how do we decide what is enough, how clean is clean?**
Allee, D. J. and Dworsky, L. B.
Water Resources Update. 88: 21-22 (1992).
NAL Call #: TD201.U61
Descriptors: Agricultural management; Environmental policy; Clean Water Act; Pollution control; Nonpoint source pollution; Water quality

28. **Implementing domestic tradable permits for environmental protection.**
Organisation for Economic Cooperation and Development (OECD).
Paris, France: Organisation for Economic Co-operation and Development, 1999. 252 p.: col. ill.: Includes bibliographical references.
Descriptors: Emissions-trading-OECD-countries; Environmental-policy-Economic-aspects-OECD-countries; Environmental-protection

29. **Incentive based conservation policy and the changing role of government.**
Sohngen, Brent
DeKalb, Illinois.: American Farmland Trust Center for Agriculture in the Environment, 1998. Center for Agriculture in the Environment Working Paper Series: CAE/WP98-6.
NAL Call #: HD256-.W67-no.-98-6
URL: http://aftresearch.org/research/resource/publications/wp/wp98-6.html
Descriptors: Environmental policy; Water quality; Economics; United States

30. **Increasing regulators' confidence in point-nonpoint pollutant trading schemes.**
Taff, S. J. and Senjem, N.
Water Resources Bulletin. 32 (6): 1187-1193 (Dec 1996).
NAL Call #: 292.9-Am34
ISSN: 0043-1370.
Descriptors: water-pollution; point-sources; pollutants; pollution-control; watershed-management; water-quality; costs; regulation; uncertainty; oregon; nonpoint-sources; water-quality-uncertainty; practice-uncertainty; enforcement-uncertainty; price-uncertainty
Abstract: One of the principal stumbling blocks to regulatory agencies' adopting pollutant trading schemes is the complex of uncertainties surrounding any change in institutions. This is especially true if nonpoint pollution sources are to be involved along with point sources. Regulators are understandably reluctant to switch from tried-and-true point source permit systems, even if trading schemes can be shown (on paper, at least) to result in lower public expenditures. We propose a set of practical criteria for point- nonpoint pollutant trading systems that promise to increase regulators' confidence that the new system will be equally effective in controlling pollution and at the same time more likely to capture efficiencies in pollution reduction practices.

31. **Innovative Water Quality-Based Permitting: A Policy Perspective.**
Downing, D. and Sessions, S.
Journal of the Water Pollution Control Federation. 57 (5): 358-365 (1985).
NAL Call #: TD419.R47
Descriptors: Water quality; Pollution control; Water pollution; Nonpoint source pollution; Environmental programs

32. **International trading arrangements, the intensity of resource use, and environmental quality.**
Young, M. D.
In Agriculture and Water Quality: International Perspectives. Edited by John B. Braden and Stephen B. Lovejoy. Boulder, Colo.: L. Rienner.; pp. 197-215 (1989).
NAL Call #: HC79.W32A37
Descriptors: International-trade; Environmental-policy

33. **Lessons learned about the performance of USDA agricultural nonpoint source pollution programs.**
Ribaudo, M. O.
Journal of Soil and Water Conservation. 53 (1): 4-10 (First Quarter 1998).
NAL Call #: 56.8-J822
ISSN: 0022-4561.
Descriptors: water-quality; water-pollution; pollution-control; environmental-protection; federal-programs; USDA; program-evaluation; United-States

34. **Managing the Water Environment: Prospects for Change.**
Zabel, T. and Rees, Y.
Water Law. 9 (5-6): 195-203 (1999).
ISSN: 0959-9754.
Descriptors: Effluents; Economics; Environmental programs; Water pollution; United Kingdom

35. **Market incentives to reduce nonpoint source agricultural nutrient pollution: A theoretical and implementational discussion.**
Norman, M. E. and Keenan, J. D.
Journal of Environmental Systems. 24 (2): 151-157 (1995).
ISSN: 0047-2433.
Descriptors: Nonpoint source pollution; Nutrients; Water pollution; Market development

36. **A new tool for water quality: Making watershed-based trading work for you.**
National Wildlife Federation.
[Montpelier, Vt.?]: National Wildlife Federation, [1999]: Title from title page of source code document. "June, 1999" Includes bibliographical references.
NAL Call #: TD365-.N48-1999
URL: http://www.water.rutgers.edu/TMDLs/Trading/newtool.pdf
Descriptors: Water-quality-management; Watershed-management

37. **Nonpoint pollution policies and politics: The role of economic incentives.**
Braden, J. B.
American Water Resources Association Technical Publication Series (TPS). 88: (4): 57-65 (Nov 1988).
NAL Call #: TC401.A5
ISSN: 0066-1171.
Descriptors: pollution-by-agriculture; water-pollution; environmental-pollution; control; programs; environmental-policy; incentives; subsidies; abatement-subsidies; transferable-discharge-permits

38. **Nonpoint sources.**
Line, D. E., McLaughlin, R. A., Osmond, D. L., Jennings, G. D., Harman, W. A., Lombardo, L. A., and Spooner, J.
Water Environment Ressearch. 70 (4): 895-912 (June 1998).
NAL Call #: TD419.R47
ISSN: 1061-4303.
Descriptors: water-pollution; groundwater-pollution; pollutants; pesticide-residues; leaching; runoff; pollution-control; low-input-agriculture; best-management-practices; nonpoint-source-pollution
Abstract: Annual literature review covers multiple aspects of nonpoint source pollution and includes references to articles on pollution trading.

39. **Nonpoint sources.**
Line, D. E., Jennings, G. D., McLaughlin, R. A., Osmond, D. L., Harman, W. A., Lombardo, L. A., Tweedy, K. L., and Spooner, J.
Water Environment Ressearch. 71 (5): 1054-1069 (Aug 1999).
NAL Call #: TD419.R47
ISSN: 1061-4303.
Descriptors: water-pollution; groundwater-pollution; groundwater; surface-water; water-quality; pollutants; runoff; leaching; agricultural-land; agricultural-chemicals; pollution-control; literature-reviews; nonpoint-source-pollution; best-management-practices
Abstract: Annual literature review covers multiple aspects of nonpoint source pollution and includes references to articles on pollution trading.

40. **Optimizing point/nonpoint source tradeoff in the Holston River near Kingsport, Tennessee.**
Podar, M. K., Jaksch, J. A., Sessions, S. L., Crossman, J. C., Ruane, R. J., Hauser, G., and Burmaster, D. E.
In *Perspectives on Nonpoint Source Pollution: Proceedings of a National Conference, Kansas City, Missouri, May 19-22, 1985.* Washington, DC: U.S. Environmental Protection Agency, Office of Water Regulations and Standards. pp. 417-424. Maps.
NAL Call #: TD223.P39
Descriptors: river-water; water-pollution; point-source; pollution-by-agriculture; waste-disposal; biological-oxygen-demand; waste-water-treatment; simulation-models; Tennessee

41. **Options for agricultural nonpoint-source pollution control.**
Ribaudo, M. O.
Journal of Soil and Water Conservation. 47 (1): 42-46 (Jan/Feb 1992).
NAL Call #: 56.8-J822
ISSN: 0022-4561.
Descriptors: pollution; control; pollution-control; water-pollution; drainage; leaching; runoff; pesticides; sediment; soil-conservation; land-policy; USDA; land-banks; federal-programs; United-States

42. **Point-nonpoint effluent trading in watersheds: A review and critique.**
Jarvie, M. and Solomon, B.
Environmental Impact Assessment Review. 18 (2): 135-157 (1998).
NAL Call #: TD194.6.E56
ISSN: 0195-9255.
Descriptors: Watersheds; Water pollution; Environmental policies; Economics; Nonpoint source pollution

43. **Point-nonpoint nutrient trading in the Susquehanna River basin.**
Horan, R. D., Shortle, J. S., and Abler, D. G.
Water Resources Research. 38 (5): 8-1-8/13 (2002).
NAL Call #: 292.8-W295
ISSN: 0043-1397.
Descriptors: Water quality; Nonpoint source pollution; Pollution load; Environmental programs; Market development; Economics

44. **Point/nonpoint source pollution reduction trading: An interpretive survey.**
Letson, D.
Natural Resources Journal. 32 (2): 219-232. (Spring 1992).
NAL Call #: HC79.E5N3
ISSN: 0028-0739
Descriptors: water-pollution; cost-control; literature-reviews; United-States

45. **Point-nonpoint source trading for managing agricultural pollutant loadings: prospects for coastal watersheds.**
Letson, David., Crutchfield, Stephen R., Malik, Arun S., and United States. Dept. of Agriculture. Economic Research Service.
Washington, DC: U.S. Dept. of Agriculture, Economic Research Service, [1993]. 14 p.: ill., map: Cover title. "September 1993"--P. [iii]. "Water quality." Includes bibliographical references (p. 13-14).
NAL Call #: A281.9-Ag8A-no.674
Descriptors: Water-quality-management-United-States; Agricultural-pollution-United-States; Nonpoint-source-pollution-United-States

46. **Point-Nonpoint Source Trading: Looking beyond Potential Cost Savings.**
Bartfeld, E.
Environmental Law. 23 (1): 43-106 (1993).

Descriptors: Environmental policy; Laws and regulations; Water quality; Water pollution; Nonpoint source pollution; Pollution prevention; Economics

47. **Point/nonpoint source trading of pollution abatement: Choosing the right trading ratio.**
Malik, A. S., Letson, D., and Crutchfield, S. R.
American Journal of Agricultural Economics. 75 (4): 959-967 (Nov 1993).
NAL Call #: 280.8-J822
ISSN: 0002-9092.
Descriptors: pollution-control; law-enforcement; costs; water-quality; trading; uncertainty; mathematical-models; ratios; United-States; abatement-costs
Abstract: In programs for trading pollution abatement between point and nonpoint sources, the trading ratio specifies the rate at which nonpoint source abatement can be substituted for point source abatement. The appropriate value of this ratio is unclear because of qualitative differences between the two classes of sources. To identify the optimal trading ratio, we develop and analyze a model of point/nonpoint trading. We find the optimal trading ratio depends on the relative costs of enforcing point versus nonpoint reductions and on the uncertainty associated with nonpoint loadings. The uncertainty does not imply a lower bound for the optimal trading ratio.

48. **Point/nonpoint source trading program for Dillon Reservoir and planned extensions for other areas.**
Elmore, T., Jaksch, J., and Downing, D.
In *Perspectives on Nonpoint Source Pollution: Proceedings of a National Conference, Kansas City, Missouri, May 19-22, 1985.* (U.S. Environmental Protection Agency, Office of Water Regululations and Standards) 1985. pp. 413-416.
NAL Call #: TD223.P39
Descriptors: water-reservoirs; water-pollution; point-source; pollution-by-agriculture; control; programs; water-composition-and-quality; monitoring; Colorado

49. **Point Sources-Nonpoint Sources Trading in the Lake Dillon Watershed: A final report.**
Northwest Colorado Council of Governments
Frisco, Colo.: Northwest Colorado Council of Governments, 1984. 45 p.
Descriptors: Nonpoint source pollution; Wastewater treatment; Water pollution; Phosphorus; Eutrophication; Water quality trading

50. **Policy objectives and economic incentives for controlling agricultural sources of nonpoint pollution.**
Horan, R. D. and Ribaudo, M. O.
Journal of the American Water Resources Association. 35 (5): 1023-1035 (Oct 1999).
NAL Call #: GB651.W315
ISSN: 1093-474X.
Descriptors: agriculture; water-pollution; pollution-control; water-quality; economics; incentives; policy; costs; USDA; United-States
Abstract: In this paper, we review the physical characteristics of agricultural nonpoint pollution and discuss the implications for setting appropriate pollution control objectives

and designing incentive-based pollution control policies. First, we discuss that policy objectives must be designed carefully to ensure positive economic net benefits can be expected from pollution control. Next, we review several classes of incentives and recommend the use of design-based incentives (i.e., incentives based on variable input use, management practices, and land use) for controlling nonpoint pollution. Cost-effectiveness requires that incentives elicit three types of responses from farmers: (1) use variable inputs at appropriate levels, (2) adopt appropriate management practices, and (3) make appropriate land use decisions at the extensive margin of production. If a set of incentives fails to induce the correct responses, the resulting runoff levels and hence ambient pollution levels and damages will be too large relative to policy goals. A review of existing programs suggests that greater program coordination and improved targeting of incentives are needed for further water quality improvements. Alternatively, properly designed market-based systems may be effective alternatives. These systems would reduce overall pollution control costs by allowing markets to allocate point source and nonpoint source control costs more efficiently.

51. **Pollution Permits and Markets for Water Quality.**
O'Neill, W. B.
PhD Thesis (1980); University of Wisconsin - Madison; 198 p.
Descriptors: Water pollution; Water quality; Models; Program planning; Economics

52. **Pronsolino v. Marcus.**
Shosteck, D.
Ecology Law Quarterly. 28 (2): 327-354 (2001).
ISSN: 0046-1121.
Descriptors: Water pollution; Nonpoint source pollution; Water quality; Clean Water Act; Pollution load; Laws and regulations; Environmental protection; Environmental policy; Total maximum daily load

53. **Reducing nitrogen flow to the Gulf of Mexico: Strategies for agriculture.**
Peters, M., Ribaudo, M., Claassen, R., and Heimlich, R.
Agricultural Outlook. 266: 20-24 (Nov 1999).
NAL Call #: aHD1751.A42
ISSN: 0099-1066.
Descriptors: Pollution-control; United-States

54. **The regulation of water pollution permit trading under conditions of varying streamflow and temperature Wisconsin permit market system, Transferable Discharge Permits.**
O'Neil, W. B.
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Descriptors: Wisconsin

55. **The role of education in nonpoint source pollution control policy.**
Ribaudo, M. O. and Horan, R. D.

Review of Agricultural Economics. 21 (2): 331-343 (Fall/Winter 1999).
NAL Call #: HD1773.A3N6
ISSN: 1058-7195.
Descriptors: water-quality; water-pollution; pollution-control; educational-programs; program-evaluation; profitability; environmental-policy; United-States
Abstract: Education is often used to provide producers with information on how to operate more efficiently with current technologies or on profitable new technologies that generate less pollution. While such "win-win" solutions to water quality problems are attractive, we use a simple economic framework to show that education cannot be considered a strong tool for water quality protection. Its success depends on a number of factors related to profitability and altruism, and "win-win" solutions are not always guaranteed, even when they appear to exist. Evidence suggests that net returns are the chief concern of producers when they adopt alternative management practices.

56. **Search for the Northwest Passage: The assignation of NSP (non-point source pollution) rights in nutrient trading programs.**
Collentine, D.
Water Science and Technology. 45 (9): 227-234 (2002).
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Descriptors: Nonpoint source pollution; Water Pollution; Water quality standards; Environmental policy; Pollution load; Law and legislation; Water Quality

57. **Simulation of a two-pollutant, two-season pollution offset system for the Colorado River of Texas below Austin.**
Letson, D.
Water Resources Research. 28 (5): 1311-1318 (May 1992).
NAL Call #: 292.8-W295
ISSN: 0043-1397.
Descriptors: river-water; water-pollution; pollutants; water-quality; environmental-impact; seasonal-variation; simulation-models; mathematical-models; Texas; pollution-control
Abstract: A pollution offset system is a discharge permit system in which transfers are made subject to a restriction that no violations of water quality standards occur at any location. Simulation of a pollution offset system with seasonal variation and multiple pollutants allows for comparison of the savings possible from these design features. A simulation model (Qual-TX) developed by the Texas Water Commission is applied to a case study region near Austin, Texas, yielding impact coefficients for an economic optimization model without investment whose least cost solution represents the theoretical equilibrium of a pollution offset system. The optimization model finds short-run savings of 17.5% for a pollution offset system, as compared to a command and control policy that would also achieve the dissolved oxygen standard. Seasonalvariation in permit design produces minimal effects; virtually all savings come from allowing pollution offsets for the two different pollutants.

58. **The structure and practice of water quality trading markets.**
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Descriptors: Water quality; Water pollution; Economics; Environmental policy; Laws and regulations; Market development

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NAL Call #: HD1773.A3N6
ISSN: 1058-7195.
Descriptors: Economics; Water quality; Pollution control; Environmental policy

60. **Trading between point and nonpoint sources: A cost effective method for improving water quality: The case of Dillon Reservoir.**
Elmore, Tom and United States. Environmental Protection Agency. Office of Policy, Planning and Evaluation. 57th WPCF Conference, 1984, New Orleans La.
[Washington, D.C.?: U.S. Environmental Protection Agency?, 1984?] 20 leaves: maps: Cover title. "The work for this study was funded by a grant"; Includes bibliographical references (leaf 20).
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Descriptors: Water-quality-management-Colorado-Dillon-Reservoir

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Hall, J. C. and Howett, C. M.
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ISSN: 1044-9493.
Descriptors: Watershed management; Water quality; Nonpoint source pollution; Economics; Laws and regulations

62. **Trading on water: Trading can be a cheaper answer to water quality problems, creating a win-win solution for all.**
Greenhalgh, Suzie and Faeth, Paul
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Descriptors: Water quality; Economics; Environmental policy; Water pollution; Pollution control; United States

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Descriptors: sediment; agricultural-land; pollution-control; permits; contracts; land-ownership; costs; simulation; flow-charts; nonpoint-pollution

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O'Neil, W. B.
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Descriptors: Water quality; Water pollution; Market development; Economics; Planning; Environmental programs

65. **Transferable Discharge Permits and Economic Efficiency: The Fox River.**
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66. **The U.S. environmental policy experience: A critique with suggestions for the European community.**
Howe, C. W.
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Descriptors: Environmental policy; United States; Water quality; Economics

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Schubauer Berigan, M. K., Smith, M., Hopkins, J., and Cormier, S. M.
Environmental Toxicology and Chemistry. 19 (4, pt.2): 1097-1105 (2000).
NAL Call #: QH545.A1E58
ISSN: 0730-7268.
Descriptors: watersheds; watershed-management; biological-indicators; trends; Ohio
Abstract: Assessment of watershed ecological status and trends is challenging for managers who lack randomly or consistently sampled data, or monitoring programs developed from a watershed perspective. This study investigated analytical approaches for assessment of status and trends using data collected by the Ohio Environmental Protection Agency as part of state requirements for reporting stream quality and managing discharge permits. Fish and benthic macroinvertebrate metrics collected during three time periods (1979-1981, 1986-1989, 1990-1993) were analyzed for the mainstem of Big Darby Creek, a high-quality warm-water stream in central Ohio, USA. Analysis of variance of transformed metrics showed significant differences among time periods for six fish metrics. In addition, significant positive linear trends were observed for four metrics plus the index of biotic integrity score, and negative linear trends for two fish metrics. An analysis of a subset of sites paired by location and sampled over the three periods reflected findings using all available data for the mainstem. In particular, mean estimates were very similar between the reduced and full data sets, whereas standard error estimates were much greater in the reduced subset. Analysis of serial autocorrelation patterns among the fish metrics over the three time periods suggests changes in the nature of stressors over time. A comparison within the most recent time

period showed significantly better condition for Big Darby mainstem than for Hellbranch Run (the easternmost subwatershed), after adjusting for watershed size. The consistency of paired and nonrandomized results suggested that either type of data might be judiciously used for this watershed. assessment. Results indicated that overall biological condition of the mainstem of the Big Darby Creek watershed has significantly improved since the early 1980s.

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Willey, Z.
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NAL Call #: TD201.U61
Descriptors: Water quality; Economics; Pollution control; Nonpoint source pollution; Water quality standards; Environmental fate

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Washington, D.C.: The Office ; Gaithersburg, MD: The Office [1992]. 15 p.: Cover title. "June 1992." "GAO/RCED-92-153." "B-247972.2"--P. 1. Includes bibliographical references.
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Brill, E. D. Jr., Eheart, J. W., Kshirsagar, S. R., and Lence, B. J.
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Chiang, Shin An.
Stillwater, Okla.: Oklahoma State University, 1986. 158 p. Thesis (Ph. D.); Includes bibliographic references.
Descriptors: Water quality; Water quality standards; Pollution load; Simulation models; Cost analysis

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Stephenson, Kurt, Norris, Patricia, and Shabman, Leonard.
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Descriptors: Economics; Water quality; Pollution control; Environmental policy

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Galya, D., Mitchell, D., and Gerath, M.
Environmental Regulation and Permitting. 7 (4): 61-66 (1998).
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Descriptors: Watersheds; Economics; Water quality; Pollution control; Environmental policy

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Descriptors: Watersheds; Water quality; Water Pollution; Environmental policy; Water quality standards; Watershed management

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Descriptors: pollution-control; environmental-policy; emission; simulation; welfare-economics; mathematical-models; uncertainty; comparisons; efficiency; social-benefits; fertilizers; runoff; statistical-analysis

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