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Economic Implications of Managing Nonpoint Forest Sources of Water Pollutants: A Midwestern Perspective*

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ABSTRACT

Economic evaluations of six forest practices designed to enhance water quality from 18 timber harvesting operations in the midwest were carried out. Net revenue reductions ranged from 1.2 percent with redesign of landing and skid trail locations to 26.4 percent with buffer strip requirements. Nine operations were profitable with application of all six practices. Limited production function information hinders such analyses.

The production of quality water from forested land has been subject for especially sharp focus during the past 5-10 years. In large measure this interest stems from 1972 and subsequent amendments of the Federal Water Pollution Control Act which, among other things, required states to define and implement "best management practices" that reduce or prevent nonpoint forest sources of water pollutants. Progress toward such a goal required the forestry community to secure a better understanding of the relationship between management/harvesting practices and the incidence of water pollutants in both physical and economic terms. The latter has proven to be especially challenging (Miles, 1982).

Economic issues involving management of nonpoint forest sources of water pollutants were addressed by a study of midwestern timber purchasers during the summer of 1983 (Miles and Ellefson 1983). Procedurally, the study involved identification of forest practices judged capable of enhancing water quality, determination of costs and revenues associated with each practice, and marginal analysis of decisions to implement one or more practices. The study's results are to be interpreted with the following in mind: only costs -- not benefits -- of managing nonpoint, forest sources of pollution were analyzed; economic impact on a single timber purchaser was of major concern -- regional impacts of alternative forest practices were not considered; forest practice outputs other than quality water were not assessed; and the analysis focused on a cost structure representative of publically owned forest land in the midwest.

SELECTION OF FOREST PRACTICES AND CASE STUDIES

Identification of forest practices considered appropriate to curbing the production of nonpoint source water pollutants -- especially sediment -- involved careful review of various literature sources, evaluation of laws and administrative rules focused on water pollutants from forest sources, and lengthy discussions with forest hydrologists and administrators in public and private service. Such actions led to selection of six practices for study, namely: skid trail and landing design, seeding and fertilizer application, water bars, broad-based dips, buffer strips, and culverts.

Information to carry out economic evaluations of quality water producing practices was obtained from records of active timber sales on nine national forests located in Illinois, Michigan, Minnesota, Missouri, and Wisconsin. In all, 18 sales were evaluated -- two from each forest. Sale selection was predicated on proximity to water (e.g., stream or lake) and on representativeness of the larger forest area in question (e.g., topography, soils, stocking level, forest type, size of sale). A thorough search of active timber sale files was carried out. Once preliminary selections were made, forest hydrologists and sale administrators were consulted to aid in the final selection process. Sale names and their location are presented in Table 1.

REVENUE AND COST CALCULATIONS

Timber sale revenues were determined by calculating the value of harvested timber delivered to the mill. Volumes were separated according to species, diameter and product (e.g., sawtimber, pulpwood). Prices for delivered timber were obtained from various sources including statewide and regional price reporting bulletins. Costs were separated into two major categories, namely, conventional harvesting costs and the cost of alternative practices. The former were reflective of practices "normally" used to harvest timber on the sale in question (e.g., felling, bucking, skidding, hauling). Alternative practice costs reflected

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additional investments in practices thought capable of enhancing or maintaining the quality of water flowing from a harvested area. Fourteen of the 18 timber sales had positive net revenues -- four were judged to be unprofitable.

ECONOMIC EVALUATIONS

Financial Impact of Single Practices

Requiring timber purchasers to undertake forest practices deemed necessary to improve the quality of water flowing from forested areas can have a pronounced effect on the net revenue realized by such purchasers. For illustrative purposes, all 18 cases were combined to form a "composite" sale which had the following character:

Practice	Added Cost of Practice (dollars)	Net Revenue (dollars)	Decline in Net Revenue (percent)
Conventional Practices	--	124,340	--
Skid Trail and Landing Design	1,556	122,784	1.2
Culverts	6,203	118,137	5.0
Water Bars	9,031	115,309	7.3
Broad-based Dips	10,946	113,394	9.7
Seeding and Fertilizer	19,808	104,532	15.9
Buffer Strips	25,948	98,392	26.4

For the composite sale, revenue reductions due to water quality improving practices ranged from 1.2 percent when landings and skid trails are redesigned to over 26 percent when buffer strips are required. A detailed accounting of financial impacts of added practices on revenue generated by each case study is presented in Table 2. In all cases, additional attention devoted to design of landings and skid trails was the least expensive practice. In nine of the 18 cases evaluated, buffer strips were the most expensive followed at a close second by seeding and the application of fertilizer (eight out of 18).

Cumulative Financial Impact of Practices

Although forest hydrologists do not completely agree on the effectivenes of sediment reducing forest practices, a ranking of practices by effectiveness and an evaluation of their cumulative impact on net revenue could prove of value to forest managers charged with design of "best management practices." Recognizing that effectiveness varies with site and that complex interrelationships occur between practices, application of practices was presumed to occur in the following order: (1) skid trail and landing design, (2) culverts, (3) water bars, (4) buffer strips, (5) seeding and fertilizer, and (6) broad-based dips. When cumulatively applied in such order, impacts on total harvesting costs and net revenue become substantial -- consider the composite sale (Table 1). Total costs rise in a modest fashion when practices through and including water bars are added (i.e., 1.5 percent); when all five practices are added to conventional practices, harvesting costs rise 6.5 percent. Net revenue impacts, however, are much more pronounced. When all practices are applied, net revenue is reduced by nearly 60 percent.

Adding water-quality enhancing practices in the order stated above has net revenue impacts that vary with the sale in question. Following is the frequency of operations that experience a net revenue equal to or less than zero when additional practices are accumulated:

	Frequency
Timber harvesting operations with zero or less net revenue with conventional practices only:	4
Timber harvesting operations with zero or less net revenue with the addition of:	
Practice 1	0
Practice 1 and 2	0
Practice 1, 2, and 3	1
Practice 1, 2, 3, and 4	3
Practice 1, 2, 3, 4, and 5	4
Practice 1, 2, 3, 4, 5, and 6	5

Excluding the four harvesting operations having less than zero net revenue given application of conventional practices, 14 of the sales have a positive net return when culverts are added and landings and skid trails are redesigned. Thirteen sales maintain economic viability with the addition of such practices plus the installation of water bars. And nine operations could proceed economically if all six additional water quality enhancing practices were adopted. Whether the operators chose to do so would depend on alternative investment opportunities.

SUMMARY AND OBSERVATIONS

Undertaking practices designed to enhance the production of quality water from forested areas implies very real economic consequences for timber harvesting. The magnitude of such impacts varies with the practice in question and the market and financial conditions faced by the timber harvester. Economic evaluations of practices designed to reduce or eliminate nonpoint forest sources of water pollutants are clouded by the lack of reliable information which clearly defines benefits -- in economic terms -- of undertaking additional practices. At the crux of the problem is sketchy production function information which links timber harvesting practices to specific levels of water pollutants generated -- or curbed.

LITERATURE CITED

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Table 1. Cumulative effect of ranked sediment reducing forest practices on net revenue from 18 timber harvesting operations in the midwest. 1983.

Sediment Reducing Practice	Added Cost of Practice (dollars)	Cumulative Total Harvest Cost (dollars)	Cumulative Net Revenue (dollars)
CASE 1: Shawnee National Forest, Illinois			
Conventional Practices	--	47,535	-2,262
Skid Trail and Landing Design	89	47,624	-2,351
Culverts	219	47,843	-2,570
Water Bars	587	48,430	-3,157
Buffer Strips	27	48,457	-3,184
Seeding and Fertilizer	762	49,219	-3,946
Broad-based Dips	458	49,677	-4,404
CASE 2: Shawnee National Forest, Illinois			
Conventional Practices	--	25,754	2,688
Skid Trail and Landing Design	10	25,764	2,678
Culverts	567	26,331	2,111
Water Bars	107	26,438	2,004
Buffer Strips	3,696	30,134	-1,692
Seeding and Fertilizer	325	30,459	-2,017
Broad-based Dips	230	30,689	-2,247
CASE 3: Huron-Manistee National Forest, Michigan			
Conventional Practices	--	56,505	16,452
Skid Trail and Landing Design	68	56,573	16,384
Culverts	504	57,077	15,880
Water Bars	1,004	58,081	14,876
Buffer Strips	1,510	59,591	13,366
Seeding and Fertilizer	918	60,509	12,448
Broad-based Dips	756	61,165	11,692
CASE 4: Huron-Manistee National Forest, Michigan			
Conventional Practices	--	176,809	25,263
Skid Trail and Landing Design	238	177,047	25,025
Culverts	--	177,047	25,025
Water Bars	844	177,891	24,181
Buffer Strips	1,698	179,589	22,483
Seeding and Fertilizer	2,148	181,737	20,335
Broad-based Dips	1,095	182,832	19,240
CASE 5: Hiawatha National Forest, Michigan			
Conventional Practices	--	14,349	943
Skid Trail and Landing Design	32	14,381	911
Culverts	219	14,600	692
Water Bars	366	14,966	326
Buffer Strips	754	15,720	-428
Seeding and Fertilizer	566	16,286	-994
Broad-based Dips	443	16,729	-1,437

Sediment Reducing Practice	Added Cost of Practice (dollars)	Cumulative Total Harvest Cost (dollars)	Cumulative Net Revenue (dollars)
CASE 6: Hiawatha National Forest, Michigan			
Conventional Practices	--	32,397	17,559
Skid Trail and Landing Design	25	32,422	17,534
Culverts	446	32,868	17,088
Water Bars	159	33,027	16,929
Buffer Strips	3,151	36,178	13,776
Seeding and Fertilizer	325	36,503	13,453
Broad-based Dips	192	36,695	13,261
CASE 7: Ottawa National Forest, Michigan			
Conventional Practices	--	32,449	-2,393
Skid Trail and Landing Design	94	32,543	-2,487
Culverts	--	32,543	-2,487
Water Bars	627	33,170	-3,114
Buffer Strips	610	33,780	-3,724
Seeding and Fertilizer	870	34,650	-4,594
Broad-based Dips	399	35,049	-4,993
CASE 8: Ottawa National Forest, Michigan			
Conventional Practices	--	47,065	6,880
Skid Trail and Landing Design	128	47,193	6,752
Culverts	514	47,707	6,238
Water Bars	1,397	49,104	4,841
Buffer Strips	1,292	50,396	3,549
Seeding and Fertilizer	959	51,355	2,590
Broad-based Dips	419	51,774	2,171
CASE 9: Superior National Forest, Minnesota			
Conventional Practices	--	245,827	6,220
Skid Trail and Landing Design	196	246,023	6,024
Culverts	1,000	247,023	5,024
Water Bars	707	247,730	4,317
Buffer Strips	2,178	249,908	2,139
Seeding and Fertilizer	3,923	253,831	-1,784
Broad-based Dips	2,325	256,156	-4,109
CASE 10: Superior National Forest, Minnesota			
Conventional Practices	--	65,055	15,129
Skid Trail and Landing Design	67	65,122	15,062
Culverts	892	66,014	14,170
Water Bars	229	66,243	13,941
Buffer Strips	1,071	67,314	12,870
Seeding and Fertilizer	1,065	68,379	11,805
Broad-based Dips	388	68,767	11,417

Table 1 - continued

Sediment Reducing Practice	Added Cost of Practice (dollars)	Cumulative Total Harvest Cost (dollars)	Cumulative Net Revenue (dollars)
CASE 11: Chippewa National Forest, Minnesota			
Conventional Practices	--	41,780	18,312
Skid Trail and Landing Design	44	41,824	18,258
Culverts	194	42,018	18,074
Water Bars	153	42,171	17,921
Buffer Strips	3,358	45,529	14,563
Seeding and Fertilizer	1,301	46,830	13,262
Broad-based Dips	558	47,388	12,704
CASE 12: Chippewa National Forest, Minnesota			
Conventional Practices	--	32,593	5,158
Skid Trail and Landing Design	44	32,637	5,114
Culverts	1,008	33,645	4,106
Water Bars	162	33,807	3,944
Buffer Strips	1,502	35,309	2,442
Seeding and Fertilizer	517	35,826	1,925
Broad-based Dips	388	36,214	1,537
CASE 13: Mark Twain National Forest, Missouri			
Conventional Practices	--	16,482	523
Skid Trail and Landing Design	36	16,518	487
Culverts	194	16,712	293
Water Bars	715	17,427	-422
Buffer Strips	1,338	18,765	-1,760
Seeding and Fertilizer	1,535	20,300	-3,295
Broad-based Dips	1,021	21,321	-4,316
CASE 14: Mark Twin National Forest, Missouri			
Conventional Practices	--	22,292	-130
Skid Trail and Landing Design	51	22,343	-181
Culverts	--	22,343	-181
Water Bars	338	22,681	-519
Buffer Strips	--	22,681	-519
Seeding and Fertilizer	725	23,406	-1,244
Broad-based Dips	348	23,754	-1,592

Sediment Reducing Practice	Added Cost of Practice (dollars)	Cumulative Total Harvest Cost (dollars)	Cumulative Net Revenue (dollars)
CASE 15: Chequamegon National Forest, Wisconsin			
Conventional Practices	--	52,849	-3,091
Skid Trail and Landing Design	80	52,929	-3,171
Culverts	446	53,375	-3,617
Water Bars	279	53,654	-3,896
Buffer Strips	1,048	54,702	-4,944
Seeding and Fertilizer	548	55,250	-5,492
Broad-based Dips	336	55,586	-5,828
CASE 16: Chequamegon National Forest, Wisconsin			
Conventional Practices	--	21,092	1,212
Skid Trail and Landing Design	32	21,124	1,180
Culverts	--	21,124	1,180
Water Bars	116	21,240	1,064
Buffer Strips	671	21,911	393
Seeding and Fertilizer	371	22,282	22
Broad-based Dips	219	22,501	-197
CASE 17: Nicolet National Forest, Wisconsin			
Conventional Practices	--	12,961	3,874
Skid Trail and Landing Design	42	13,003	3,832
Culverts	--	13,003	3,832
Water Bars	300	13,303	3,532
Buffer Strips	291	13,594	3,241
Seeding and Fertilizer	448	14,042	2,793
Broad-based Dips	152	14,194	2,641
CASE 18: Nicolet National Forest, Wisconsin			
Conventional Practices	--	193,801	12,003
Skid Trail and Landing Design	280	194,081	11,723
Culverts	--	194,081	11,723
Water Bars	937	195,018	10,786
Buffer Strips	1,753	196,771	9,033
Seeding and Fertilizer	2,502	199,273	6,531
Broad-based Dips	1,219	200,492	5,312

Table 2. Cumulative effect of ranked sediment reducing forest practices on net revenue from 18 timber harvesting operations in the midwest (composite sale). 1983.

Sediment Reducing Forest Practice	Added Cost of Practice (dollars)	Total Cost of Harvest (dollars)	Net Revenue* (dollars)	Reduction in Net Revenue (percent)
Conventional Practices	--	1,137,595	124,340	--
Skid Trail and Landing Design	1,556	1,139,151	122,784	1.3
Culverts	6,203	1,145,354	116,581	6.2
Water Bars	9,031	1,154,385	107,550	13.5
Buffer Strips	25,946	1,180,333	81,602	34.4
Seeding and Fertilizer	19,808	1,200,141	61,794	50.3
Broad-based Dips	10,946	1,211,087	50,848	59.1

*Total revenue = $1,261,935.

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