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Economic Analysis of the Mountain Fork River Trout Fishery in Southeastern Oklahoma[1]

Se-Hyun Choi, Dean F. Schreiner, David M. Leslie Jr., and Jack Harper[2]

Introduction

The development and operation of a natural resource project frequently impacts adjacent resources; e. g., ecological change downstream of a multi-purpose water project. This benefit-cost study represents an analysis of the ecological change downstream from Broken Bow Dam in southeastern Oklahoma. Construction of the dam altered the periodic rate of water flow and water temperature, which in turn changed ecology downstream of the dam (Harper). Broken Bow Lake was authorized by the Flood Control Act and approved July 3, 1958 (Public Law 85-500 85th Congress, 2d Session) in accordance with the recommendations of the Chief of Engineers in House Document No. 170, 85th Congress, 1st Session (U. S. Army Corps of Engineers). Preconstruction planning was initiated in 1959, and initial construction funds were appropriated for FY 1961. Project purposes included flood control, water supply, and hydroelectric power. Conservation of fish and wildlife was a purpose of the project authorized by the Fish and Wildlife Coordination Act (Public Law 85-624).

Before construction of the Broken Bow Dam, the Mountain Fork River was inhabited by warm water fish species. After construction, operation of the hydropower complex released large volumes of cold water (water released from lower depths of the reservoir) into the river making water temperature regimes uncertain and irregular (mixed warm water and cold water) and changing the periodic rate of water flow. For several miles below the dam, the changed environment of the river was less habitable to the native fish species. Presumably, these downstream costs were included in the original evaluation of the project. But what about current conditions? By converting the water temperature regime from uncertain and irregular to certain and regular cold water, a different type of fishery could be established.

In 1986, a preliminary biological feasibility study for a trout fishery

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was initiated by the Oklahoma Department of Wildlife Conservation (Department) and the U.S. Fish and Wildlife Service (Service) with assistance from the U.S. Army Corps of Engineers (Corps). Positive results of that study provided the basis for developing a trout fishery on the river below Broken Bow Dam. On Jan. 1, 1989, the Department designated approximately 12 miles of the river and tributaries from Broken Bow Dam downstream to the U.S. Highway 70 bridge as a year-round trout fishery (Harper).

The Department established the trout fishery by stocking 3,850 catchable (8.5-inch minimum) rainbow trout on a biweekly basis from Jan. 1, 1989, to the current period (Harper). The trout were stocked in areas below the Broken Bow Dam to U.S. Highway 70, including the Beavers Bend State Park. The Corps was contracted to release water from the Broken Bow Lake at appropriate times and in sufficient volume to maintain the environment for the operation of the year-round trout fishery.

An economic evaluation of the trout fishery was needed to (1) assess the feasibility of the project, (2) justify current and future public expenditures, and (3) manage the public resource efficiently. Costs of the project included operation and maintenance (O&M) costs of the trout fishery and opportunity costs foregone from implementation of the project. Trout-stocking costs were included as O&M costs. Opportunity costs included the value of water released exclusively for maintaining the trout fishery and the benefits foregone from prior fishing activities. Benefits of the project were determined from angler use of the trout fishery. Market transaction information on the demand for the trout fishery by anglers was not available for estimating benefits. Thus, nonmarket valuation methods were required to achieve the needed evaluation. No other benefits or costs were considered.

The principal objectives of this study were to: (1) assess the economic value of the year-round trout fishery in the river below Broken Bow Dam, (2) provide summary characteristics data about the anglers and the fishery, and (3) evaluate management and policy decisions for the fishery based on the study results. This article presents results on objectives (1) and (2). Additional information on characteristics data and procedures of the study are in (Choi et al.).

Survey Data Results[3]

Total angler hours and trout harvest were estimated by the Department for the three years of the trout fishery based on the pressure count and creel surveys (Table 1). Estimated total angler hours was slightly higher

3 Survey results are based on mail and telephone surveys administered for the first three years of the project. Procedures are available in (Choi et al.).

TABLE 1

ESTIMATED SEASONAL ANGLER HOURS AND TROUT HARVEST FOR THE FIRST THREE YEARS OF THE MOUNTAIN FORK RIVER TROUT FISHERY[a], 1989-1991

Season	1989 Jan. 1, 1989 - Nov. 30, 1989 Angler Hours (no.)	1989 Jan. 1, 1989 - Nov. 30, 1989 Trout Harvest (no.)	1989 Jan. 1, 1989 - Nov. 30, 1989 Trout Harvest (no./hr.)	1990 Dec. 1, 1989 - Nov. 30, 1990 Angler Hours (no.)	1990 Dec. 1, 1989 - Nov. 30, 1990 Trout Harvest (no.)	1990 Dec. 1, 1989 - Nov. 30, 1990 Trout Harvest (no./hr.)	1991 Dec. 1, 1990 - Nov. 30, 1991 Angler Hours (no.)	1991 Dec. 1, 1990 - Nov. 30, 1991 Trout Harvest (no.)	1991 Dec. 1, 1990 - Nov. 30, 1991 Trout Harvest (no./hr.)
Winter (Dec.-Feb)	11,493[b]	10,146[b]	0.9	16,181	23,890	1.5	13,512	10,332	0.8
Spring (Mar. - May)	18,606	13,353	0.7	21,569	13,589	0.6	29,893	12,147	0.4
Summer (June - Aug.)	26,472	9,536	0.4	18,209	9,056	0.5	32,155	9,026	0.3
Fall (Sept. - Nov.)	11,520	6,905	0.6	12,686	7,701	0.6	16,688	7,113	0.4
Total	68,091[c]	39,940[c]	0.6	68,645	54,236	0.8	92,248	38,618	0.4

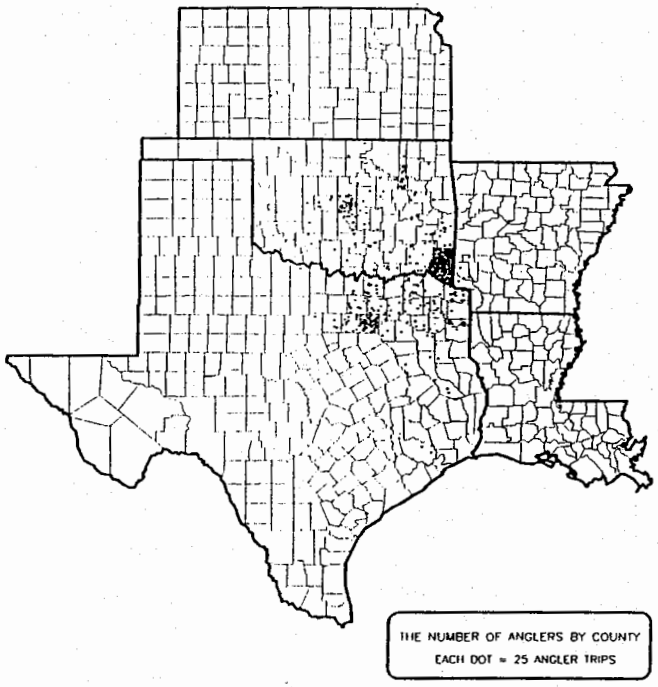
a The source for these data are Oklahoma Department of Wildlife Conservation surveys.

b Two months (Jan. and Feb., 1

c Eleven months (Jan. - Nov., 19

for the second year compared with the first year (11 months) and substantially higher for the third year compared with the first and second years. Estimated trout harvest increased from about 40,000 in the first year to about 54,200 in the second year, but decreased in the third year to about 38,600. Trout harvest rate, which was computed by dividing estimated trout harvested by angler hours, increased in the second year because of the increment in the trout harvest for that year, but decreased substantially in the third year because of a decrease in the total number of trout harvested and an increase in total angler hours. Seasonal variation showed substantially greater numbers of angler hours during spring and summer seasons compared with fall and winter.

Information from the creel and telephone surveys was combined to m[illegible]he estimated number of angler trips by county of residence (Figure 1). [illegible]he geographic data seemed consistent for 1990 and 1991 and thus were combined into one map. The highest number of trips were taken by local anglers from McCurtain County. The metropolitan areas of Dallas/Fort Worth, Oklahoma City, and Tulsa also showed high frequency of angler trips. The state boundary of Oklahoma appeared to limit the number of anglers from Arkansas and Louisiana but was less of a



igure 1. The estimated number of angler trips to the Mountain Fork River rout Fishery based on the Creel Survey, 1990-1991.

constraint to anglers from Texas. The cost of out-of-state fishing permits and alternative in-state trout fisheries probably limited Arkansas anglers from participating in the trout fishery. There are fewer in-state trout fisheries in Texas. Over 90 percent of the anglers were Oklahoma and Texas residents. Except in fall, Oklahoma residents made up > 50 percent of the total anglers. A higher proportion of anglers was from McCurtain County during the winter season compared with the other seasons. The percentage of anglers from out-of-state was higher for spring, summer, and fall compared with winter.

Number of fishing trips per angler by season are shown in Table 2. Average number of fishing trips per angler was highest during winter, with more than eight trips. Other seasons ranged from about 2.7 to 5.9 trips per season. Over 48 percent of the anglers who took a trip to the fishery during spring, summer, and fall did not take another trip during the same season.

Angler expenditures per trip were estimated and classified by category (food, lodging, transportation, etc.) and by location of purchase ($\leq$ 25-mile radius of the fishery, outside 25-mile radius but within State of Oklahoma, or outside State of Oklahoma). The distribution of angler trips by level of expenditure is presented in Table 3. The expenditure per angler per trip averaged over all seasons ranged from about $60 to $90 over the three years. Seasonal differences in angler expenditures are evident for 1990 and 1991. Spring, summer, and fall expenditures per angler per trip were two to three times greater than for winter in 1990, but differences were smaller for 1991. Most anglers spent < $20 per trip during winter, but most spent > $50 per trip in the other seasons. Generally, > 70 percent of angler expenditures occurred in the local area or within a 25-mile radius of the fishery. There were no significant seasonal differences in the distribution of angler expenditures by location.

Several important findings result from the sample data of the trout fishery and participating anglers:

1. Seasonal variation in angler hours was significant. The number of angler hours in spring and summer was about 66 percent of the total angler hours in 1989, about 58 percent in 1990, and about 67 percent in 1991. The trout harvest per angler per hour was much higher in winter than in the other seasons, which may indicate a need to adjust stocking rates by either lowering the rate during winter or increasing the rate during spring and summer. This result will depend on seasonal differences in the benefit-cost ratios (see later conclusions).
2. Seasonal differences existed in where anglers were coming from. Most winter anglers were from local areas, but higher proportions of anglers came from areas of greater distance in other seasons. Over 29 percent of the anglers came from McCurtain County; approximately 55 percent of the anglers came from the State of Oklahoma (including McCurtain County).

TABLE 2

SEASONAL NUMBER OF FISHING TRIPS PER ANGLER TO THE MOUNTAIN FORK RIVER TROUT FISHERY, 1989 - 1991

Number of Trips	1989[a] Percent	1990 (Percent) Winter	Spring	Summer	Fall	1991 (Percent) Winter	Spring	Summer	Fall
1	16.6	21.1	58.1	48.4	53.2	25.0	50.6	48.1	61.3
2 - 5	30.6	30.5	24.4	33.0	26.6	26.3	25.9	27.2	30.0
6 - 10	18.5	16.8	5.8	8.8	5.3	22.5	8.6	4.9	5.0
11 - 15	10.8	11.6	3.5	4.4	4.3	20.0	8.6	8.6	2.5
16 - 20	1.3	5.3	2.3	1.1	3.2	3.8	3.7	2.5	0.0
> 20	22.2	14.7	5.8	4.4	7.5	2.5	2.5	8.6	1.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average (No.)	15.15	11.80	4.61	4.87	5.09	8.21	5.89	5.94	2.74

[a] Annual average number of fishing trips to MFR for a sample of anglers.

TABLE 3

ESTIMATED EXPENDITURE PER ANGLER PER TRIP TO THE MOUNTAIN FORK RIVER FOR SAMPLES OF ANGLERS, 1989 - 1991

Expenditure per Angler ($)	1989[a] Percent	1990 (Percent) Winter	Spring	Summer	Fall	Annual[b]	1991 (Percent) Winter	Spring	Summer	Fall	Annual[b]
0.01 - 10.00	27.7	41.1	17.4	16.5	11.7	26.0	36.3	21.0	17.3	10.0	21.4
10.01 - 20.00	21.0	14.7	3.5	9.9	11.7	10.7	20.0	12.3	4.9	7.5	10.9
20.01 - 50.00	18.9	23.2	16.3	13.2	16.0	18.4	10.0	4.9	22.2	25.0	14.6
50.01 - 100.00	11.9	10.5	17.4	19.8	17.0	15.0	23.8	39.5	30.9	26.3	31.2
100.01 - 200.00	13.8	7.4	30.2	22.0	30.9	19.3	6.3	18.5	23.5	28.8	19.0
> 200.00	5.9	3.2	15.1	18.7	12.8	10.6	3.8	3.7	1.2	2.5	2.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average ($)	61.72	42.18	122.19	135.97	113.84	91.13	49.97	68.92	66.93	72.88	64.77
Median ($)	NA	20.0	100.0	100.0	89.0	NA	18.5	60.0	60.0	56.5	NA

[a] Weighted by zip code proportions in creel survey.

[b] Weighted by the estimated proportion of trips taken each season by anglers.

3. The average length of trip was shorter in winter than spring, summer, or fall. Annual average length of trip increased slightly year by year, from 1.51 days in 1989 to 2.39 days in 1990 to 2.63 days in 1991.
4. Except for winter, the number of fishing trips per angler by season was fairly uniform and ranged from 2.7 to 5.9 trips per season. During winter, the average number of trips per angler was over 8.
5. The median annual household income was $30,000-$40,000, indicating a relatively high income class of anglers. Anglers using the fishery in winter and summer had lower income levels than anglers in spring and fall.
6. Average expenditure per angler per trip ranged from $42 to $136, depending on season and fishing year.
7. Establishment of the trout fishery increased the frequency of trips by anglers. The average number of trips per year increased from 6 before Jan. 1, 1989, to 15 after Jan. 1, 1989.
8. Aggregate trip expenditures were estimated as $517,000 to $792,000 per year. From 73 to 84 percent of these expenditures (i.e., $413,000-$655,000) were estimated to occur within a 25-mile radius of the fishery.

Benefit-Cost Analysis

Benefits and costs of the trout fishery are summarized in Table 4. Benefits were limited to the estimated consumer surplus attributed by anglers to the fishery by means of a travel cost model (see Choi, 1993 for the complete analysis). Costs of the fishery included operation and maintenance and opportunity costs. O&M costs explicitly associated with the fishery were the costs of stocking 3,850 rainbow trout at different locations on the river on a biweekly basis and were adjusted to the 1991 price level[4].

Opportunity costs included the cold water releases from Broken Bow Lake and value of fishing activities prior to implementation of the fishery. Water storage capacity in Broken Bow Lake is for flood control, hydroelectric power generation, municipal and industrial water supply, and recreation and wildlife use, as reported in the U.S. Army Corps of Engineers Master Plan (Uwakonye). There is currently abundant unallocated water in Broken Bow Lake; hence, conflict in water usage is not an issue. For this study, the value of water used from Broken Bow Lake was assumed at a zero opportunity cost. When the situation changes and conflicts occur in the amount of water use, the value of water used for the trout fishery should be included in total project costs.

4 O&M costs excluded department costs for personnel, equipment, and travel for purposes of law enforcement and water quality monitoring. Because revenue from trout license was excluded as a benefit, it was assumed that department costs above normal fishery management should also be excluded.

TABLE 4

BENEFITS AND COSTS OF THE MOUNTAIN FORK RIVER TROUT FISHERY, 1989-1991

Year	Benefits ($)	Costs		Benefit-Cost Ratio	
		Operation[a] ($)	Opportunity Costs[b] ($)	Excluding Opportunity Costs	Including Opportunity Costs
1989[c]	1,009,000	72,951	85,036	13.8	6.4
1990					
Winter	240,000	17,994		13.3	
Spring	325,000	17,994		18.1	
Summer	257,000	17,994		14.3	
Fall	143,000	17,994		7.9	
Total	965,000	71,976	89,630	13.4	6.0
1991					
Winter	161,000	17,267		9.3	
Spring	449,000	17,267		26.0	
Summer	326,000	17,267		18.9	
Fall	189,000	17,267		10.9	
Total	1,126,000	69,068	93,402	16.3	6.9

a Cost of trout stocking adjusted to the 1991 price level. Trout license revenue was assumed ≥ management costs of fishery.

b Opportunity costs represent value of fishing days prior to 1989. Costs are in 1991 price level. Seasonal information not available.

c 11 months.

Prior to implementation of the trout fishery, there was an average of 6.3 trips per angler and after implementation, 15.2 trips for the sample of anglers in 1989. Estimated trips taken prior to Jan. 1, 1989, were approximated at 3,483, which was 42 percent of the estimated trips in 1989. Unit day value of $19, recommended by the U.S. Forest Service[5], was multiplied by 3,483 to estimate total benefits prior to implementation of the fishery. All fishing trips were assumed to be one day trips. This assumption is plausible because most trips were probably taken by local anglers prior to Jan. 1, 1989. Opportunity costs are shown in Table 4.

Overall benefit-cost ratios were computed based on the estimated net angler benefits and costs of the trout fishery (Table 4). The benefit-cost ratios, excluding opportunity costs, were about 14:1 for 1989, 13:1 for

5 Unit day value (1982 price level) per visitor day (12 hours) for wildlife and fish activity with standard quality provided in Southeastern region (Walsh).

1990, and 16:1 for 1991. When opportunity costs of foregone fishing activities were included, benefit-cost ratios decreased to about 6:1 for 1989 and 1990, and 7:1 for 1991. However, all of the ratios were greater than 1:1, implying that the angler benefits from the trout fishery were far greater than the costs of the project from 1989 to 1991.

Seasonal analysis for 1990 and 1991 showed that the benefit-cost ratios, excluding opportunity costs, were substantially higher for spring and summer compared with fall and winter. The stocking rate does not vary by season even though angler hours, angler trips, and type of angler (local, state, or out-of-state) varied substantially by season.

Public revenue from fishing licenses or trout licenses is generally excluded in benefit-cost analysis because such analysis is concerned with real resource benefits and costs, not transfer payments (Propst and Gavrilis). The number of trout licenses and revenue increased each year of the trout fishery. The revenue was equal to 55 percent of stocking costs in 1989, 68 percent in 1990, and 77 percent in 1991 (Harper). Furthermore, because a fishing license was required before purchase of a trout license, a portion of the license revenue may be allocated to the trout fishery activity. The number of trout fishing trips to total fishing trips per angler ranged from 36 percent to 59 percent, depending on year. Including these proportions of the fishing license revenue with the trout license revenue would substantially exceed the trout stocking costs for each year of the fishery. However, more intensive management of the trout fishery compared with other fisheries may increase cost.

Discussion

The overall objective of this study was to analyze the economic value of a trout fishery established in the Mountain Fork River below Broken Bow Dam. Economic evaluation of the fishery was conducted employing benefit-cost analysis for the three years of operation (1989-1991). Benefits were assumed equal to the surplus value (consumer surplus) anglers placed on the fishery. This value was estimated using the individual travel cost method. Costs of the fishery project included operating costs and opportunity costs. Operating costs were limited to the cost of trout stocking. Opportunity costs were identified as costs of cold water released from Broken Bow Lake and benefit loss from fishing activities prior to implementation of the fishery. Abundant unallocated water in the Broken Bow Lake allowed for the assumption of zero opportunity cost of cold water releases for the trout fishery. Information on the average number of trips taken before the trout fishing project in 1989 was used to estimate benefit loss. The benefit-cost ratios for the fishery excluding opportunity costs ranged from 13:1 to 16:1. When including opportunity costs, the range was from 6:1 to 7:1. Seasonal variation in benefit-cost ratios were shown for 1990 and 1991.

Conclusions

(1) Travel cost and time cost of trip affected the number of trips taken b anglers significantly and consistently throughout the three-yea period of analysis (1989-1991). This conclusion is based on th analytical results of the classical travel cost model and empirica significance of the estimated demand equations.

(2) The trout fishery has been widely accepted by residents in Oklahom and frequent visitors from other states. Reasons to support thi conclusion include the following:

(a) Annual number of trips has increased in each of the three years with an estimated 11,075 trips in the last year.

(b) Over 70 percent of the sampled anglers in each of the years gave quality index of 7 or more out of a scale of 1 to 10. Over 65 percen of the anglers sampled in 1989 stated that the trout fishery wa adequate and should be maintained, and an additional 32 percen stated that the fishery was adequate but needed to be impr[illegible]ed.

(c) The estimated one-way travel distance for the sampled angl[illegible]a increased each year of the project, implying that a wider populatio base is becoming aware of the fishery. Similarly, the averag length of trip has increased each year, implying anglers are not onl coming from greater distances but also staying longer each trip.

(3) Seasonal variation in composition of angler trips is significant. Mor trips are taken by local anglers (McCurtain County) in the winte season compared with the other seasons. In general, expenditure pe angler trip is less in winter compared with the other seasons. Th purpose of the trip is exclusively for trout fishing more in winter tha other seasons. Finally, the estimated net benefits per trout harveste are lower in winter compared with other seasons.

(4) The trout fishery generated approximately $1 million dollars of angle net benefits for each of the three years, 1989-1991.

(5) Overall benefit-cost ratio implies that benefits of the trout fishery fa exceed costs.

(6) Summary sample data show that about 33 percent of angle[illegible]rip originated from residents in McCurtain County but only accou[illegible]fo about 6 percent of angler expenditures. Conversely, 67 percent of th angler trips originated from residents outside of the county an accounted for 94 percent of total expenditures. A high proportion o total angler expenditures associated with the trout fishery originate with anglers from outside of the county, which provides for a potentia significant impact on the local economy.

Management and Policy Decisions

Based on the above conclusions and on other results of the study, th following are suggested guidelines for management and policy decision

concerning the trout fishery.

1) The benefit-cost analysis justifies strong consideration for continuing the fishery. Public acceptance, and associated attributed value, of the fishery is the basis for this proposed policy decision. If opportunity costs on water release should change or if anglers change their apparent value of angler trips, there should be a reevaluation of the trout fishery.
2) Net angler benefits per trout harvested and variation in the seasonal benefit-cost ratios indicate that change in stocking rates among seasons would increase net benefits of the trout fishery. In particular, it would enhance overall angler benefits if a higher proportion of trout were stocked during the spring and summer seasons compared with winter and fall.
3) The trout fishery has been well received by the public as evidenced by results of a quality index ranking. However, size of trout is an important factor in the quality of the fishing trip, as assessed by anglers. Therefore, increasing the size of trout stocked or a portion of the stocking has potential for inducing more angler trips.
4) The primary beneficiaries of the trout fishery are the anglers themselves. Therefore, the anglers should be assessed the major costs of operation of the fishery. Increasing the cost of the trout license as costs of stocking increase is one way to ensure that anglers are paying in accordance with benefits received.
5) Expenditure data indicate that anglers from outside the county account for a major part of the total expenditures. Thus, county businesses and county population benefit from the trout fishery. A county sales tax would be one means of generating revenue to maintain the fishery and associated facilities such as access roads.

Limitations of the Study

1) The current study accounts for only user benefits and excludes possible non-user benefits, which may lead to an underestimation of the total benefits of the trout fishery.
2) Opportunity cost of water used from the Broken Bow Lake for the trout fishery was assumed to be zero, which may not be true in the future as demands for water increase or conflicts in timing of water use become important. Projection of demands and conflicts in timing of water use were not critically analyzed.
3) Congestion at the river and capacity of the local economy to handle angler demands were not problems; however, such constraints were not measured. There may be critical areas where congestion or capacity constraints limit the ability of the trout fishery to handle increased demand. Such areas may include access roads, sanitary facilities at the fishery, or hotel lodging.

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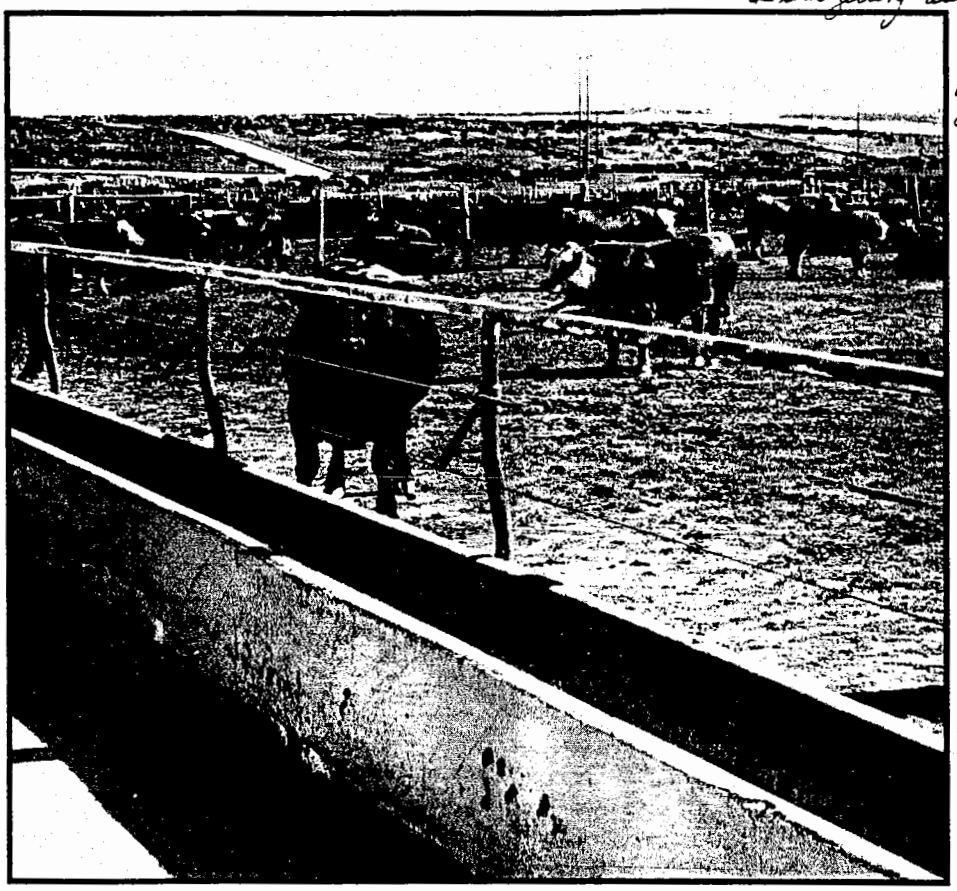
OKLAHOMA CURRENT FARM ECONOMICS



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On the cover—Each year, millions of dollars are transacted in the cattle feeding business. Feedlots such as the one on this cover contribute to the economic stability of the state. Understanding the profit risk in cattle feeding is important to risk management strategies.

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