PLANNING TECHNIQUES FOR RENOVATION AND MANAGEMENT OF THE DEEP FORK RIVER, NORTHCENTRAL OKLAHOMA

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PREFACE

A balanced coexistence between a stream ecosystem and society can and should exist, particularly for those individuals owning land within a stream's floodplain boundaries. Such a coexistence depends on successful functioning of a stream in draining its adjoining floodplain and watershed, as well as on wise land-use preferences and decisions consistent with environmental constraints within the stream basin. Where natural or human forces have disrupted the balance, environmentally sound and socially effective stream improvement measures must be implemented. The intent of this study was to investigate whether renovating a reach of the Deep Fork River would be a viable alternative to channelization proposed for the stream.

Originally, renovation of the Deep Fork appeared to be an hydraulic, social, and biological challenge. The thesis conveys how the first two components were met. Specifically, I intended to show that flood stages could be effectively reduced by channel renovation. Also, I intended to determine if floodplain landowners considered renovation an acceptable alternative to channelization. Results indicated that channel renovation can reduce flood stages from small to medium storm events. Also, a nearly equal percentage of floodplain landowners supported stream renovation compared to those supporting channelization alternatives with or without a navigation component included.

ACKNOWLEDGMENTS

This study was made possible by landowners in Lincoln and Creek Counties, Oklahoma, who graciously donated their time, patience, and insight to a study designed to address some of their stream-related problems. I hope that my work has provided solutions for their benefit.

Financial and material support from the Center for Water Research, Department of Zoology and Cooperative Fisheries and Wildlife Research Unit at Oklahoma State University, were instrumental in development of this study. Special thanks go to the individuals at the U.S. Fish and Wildlife Service in Grand Island, Nebraska, who patiently endured completion of the thesis.

Dr. John S. Barclay deserves my deepest thanks for his sincere and undying inspiration and partnership during this project. I trust these will not end here. I have greatly appreciated the personal and professional input provided by Dr. Gene Maughan, Dr. Bruce Wilson, Dr. Chip Leslie, and Mr. Don Spurrier. Additional thanks are extended to the long list of those who surrounded me with free thought, friendship, and good times.

Finally, I wish to dedicate this thesis to those who have been most important in my life, namely Debbie, my wife, Josh, my son, and Richard

and Dorothy Taylor, my parents. Together, they have been my primary motivation by having shared a belief in me and in my accomplishments.

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CHAPTER I

RENOVATION OF A PLAINS STATE STREAM -- PHYSICAL PROBLEM SOLVING

Thomas J. Taylor

John S. Barclay

Abstract.--Quantifiable methods do not exist to assess hydraulic effects of stream renovation. To obtain such methods, channel obstructions were modeled from field data. These models were used to show changes in flood stages resulting from obstruction removal. This simulation may provide an approach for resource planners to predict flood water control without costly stream channelization.

INTRODUCTION

Recent years have brought an alternative approach called renovation to flood control and stream improvement projects. Renovation typically includes removal of channel blockages, selective snagging, revegetation of eroding banks, and minor dredging. Renovation is designed to improve drainage capabilities at a fraction of the cost of other channel modification techniques while retaining the biological and aesthetic integrity of the stream system. This approach contrasts sharply with

traditional stream modification philosophy because it seeks to minimize adverse impacts to fish and wildlife resources (Simpson et al. 1982), channel instabilities (Nunnally 1978), and high construction and maintenance costs (Council on Environmental Quality 1973, Nunnally and Keller 1979, McConnell et al. 1980).

Renovation planning and assessment of the effectiveness of hydraulic improvements often have been subjective (Herbkersman 1982, Stream Renovation Guidelines Committee 1982). As a result, water resource planners and decision-makers find renovation procedures difficult to apply and evaluate and often opt for channelization (McConnell et al. unpublished). This paper reports a quantified procedure for planning renovation and for simulating its effectiveness as reflected in changes to water surface elevation (WSEL).

STUDY AREA

The study was conducted on the Deep Fork branch of the North Candian River between river miles 159.33 and 180.96. The reach is located in eastern Lincoln County, Oklahoma, and drains nearly half of the 272 sq km Deep Fork watershed.

Herbaceous communities on this portion of the watershed are transitional between the tallgrass and midgrass prairies (Penfound 1967). Post oak-blackjack oak predominate in the uplands (Rice and Penfound 1959) while bottomland forests are dominated by American elm (Ulmus americana), hackberry (Celtis occidentalis) and green ash (Fraxinus pennsylvanica) (Rice 1965). Agricultural development of the

floodplain followed original channelization of the river that occurred from 1912-1923 (Harper 1937) and extended from downstream of Oklahoma City eastward to the Lincoln-Creek County line. Consequently, much--and in many locations all--of the riparian forest has been cleared and bermuda grass (Cynodon dactylon) pastures and crops, principally wheat (Triticum sp.), alfalfa (Medicago sativa) and grain sorghum (Sorghum vulgare), have been planted (U.S. Fish and Wildlife Service 1979).

However, agricultural activities in the floodplain have been hampered since 1940 by floodplain inundation that currently lasts for 8 to 10 months annually. This inundation has resulted from the loss of channel capacity caused by watershed soil erosion, a lack of stream maintenance, and ongoing disposal of riparian timber into the channel. The study area centers around a large logjam which blocks a continuous 1.6 km of the former channel and creates overland flows. This logjam is part of an 11 km section of the original dredge channel. Since the early 1980's, a channel along an old meander has intruded in agricultural land and bypassed the blocked section. Additional isolated flow blockages are located throughout the study area.

For purposes of this report, we have divided the channel into three main subreaches: 1) subreach I, channelized around 1912 and again periodically from 1974 to the present; 2) subreach II, originally channelized (ca 1912) but currently obstructed, and circumvented by a meander channel; and 3) subreach III, also channelized around 1912 but currently unobstructed (Figure 1).

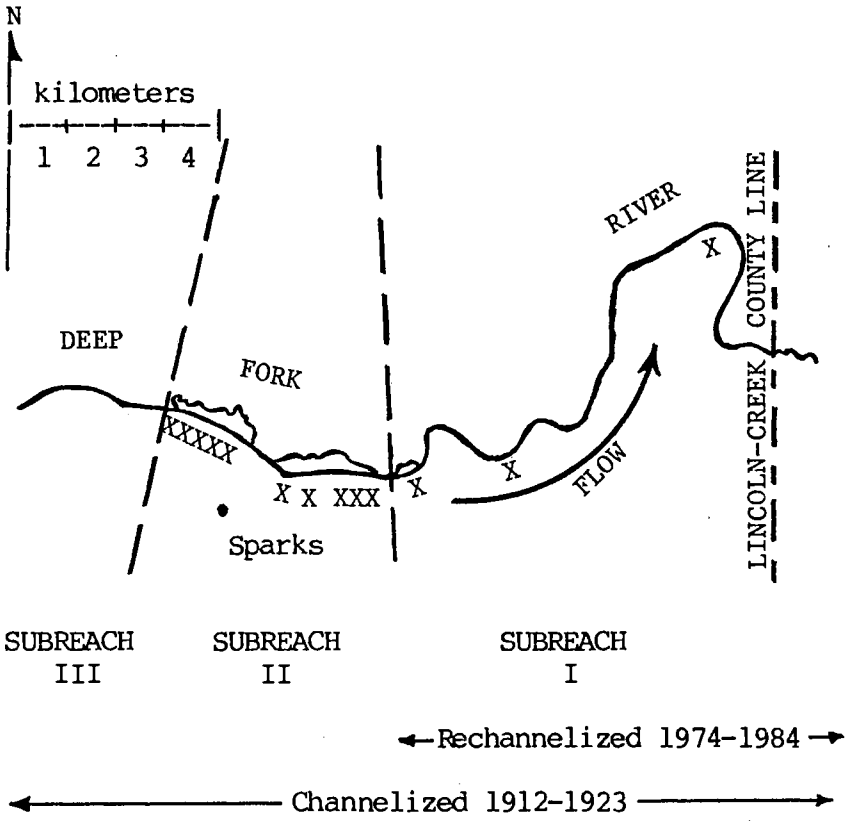


Figure 1.--Eastern Lincoln County Oklahoma showing subreach divisions for the Deep Fork River renovation study. A new meander channel currently bypasses substantially obstructed portions of subreach II. (Locations of blockages (X) are generalized and not to scale.)

METHODS

Field Inspection

Air and ground reconnaissance were used to evaluate channel obstructions. Air reconnaissance followed the general techniques suggested by George Palmiter (Herbkersman 1982). Present channel location, general obstruction classes (Stream Renovation Guidelines Committee 1982), the location of discrete channel blockages, and their relative sizes were plotted on a series of U.S. Geological Survey (USGS) 7 1/2 minute quadrangle maps (scale = 1:24,000). A blockage was defined as any organic or inorganic materials which spanned or filled the channel. Blockages typically caused water to pond or be diverted into the floodplain (Stream Renovation Guidelines Committee 1982).

To verify aerial observations, 40 randomly selected sample sites (between two and three sites per river mile) were visited. At each site two-100 m transects, one parallel and one perpendicular (i.e. a riparian transect) to the channel, were established. Each transect was divided into 4-25 m segments and the following information was obtained for each segment. A Manning's roughness coefficient, n, was determined based on Chow (1959) and Barnes (1967). In the channel transect, bank slope was classified as less than 1, 1, 2, 3, 4, or greater than 4; depth was estimated to within 0.5 m; and width was measured with a 100 m tape. Each blockage was measured for its general length, width, and height.

Modeling and Computer Simulation

Water surface profiles were obtained for the study area by

simulating prerenovation or blocked conditions and postrenovation or unblocked conditions. Development of profiles was facilitated by the HEC-2 computer software package made available through the U.S. Army Corps of Engineers (COE), Davis, California. The HEC-2 program computes water surface profiles iteratively by the standard step method for streams with slopes less than 1:10.

Baseline data of floodplain topography (i.e., USGS photogrammetry of 1973) were collected from the COE Tulsa District, Tulsa, Oklahoma, and adapted to include floodplain cross section data. These cross sections did not correspond to the 100 m transects previously described. Data from 15 of the 19 USGS channel cross sections were modified based on field observations. Discharge values associated with the local 2-, 5-, and 10-year frequency floods also were provided by the COE and were derived from gauge readings recorded downstream from the study site. No adjustments to discharge values were made for simulations in the study reach.

Channel dimensions and roughness coefficients determined in the field were derived for each 100 m transect by averaging the values assigned for each of the 4-25 m segments. These final values were used in place of generalized values used by the COE. Roughness coefficients resulting from the riparian transects were used to define overbank conditions and were assumed to represent both left and right overbanks. To adequately describe channel blockages, additional cross sections were developed by interpolation (Figure 2) following procedures used by the COE (U.S. Army Corps of Engineers 1982).

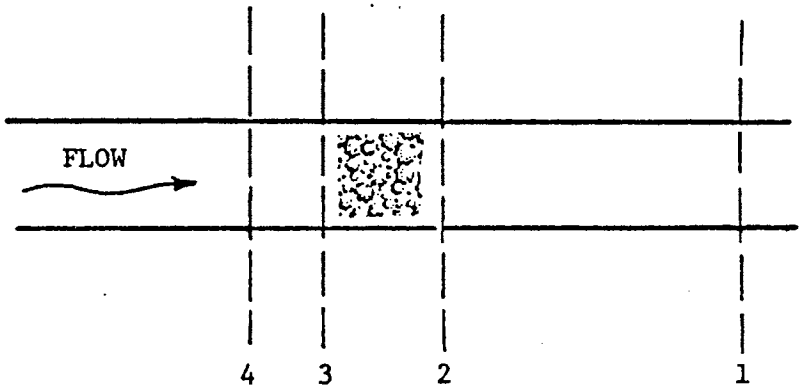


Figure 2.--An aerial view of the Deep Fork River demonstrating the placement of interpolated cross sections used to hydraulically define a channel blockage.

Blockages were assumed to be one of four general geometric shapes (Table 1), and 14 representative blockages (Appendix A) were simulated (Figure 3) at appropriate channel locations (Figure 1). Values for roughness coefficients as well as contraction and expansion coefficients were assigned to reflect energy losses resulting from a blockage (Table 1).

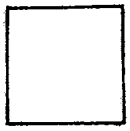
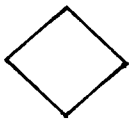
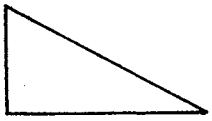
After present floodplain and channel conditions were modeled, water surface profiles were generated for 2-, 5-, and 10-year frequency events. These profiles then were compared to those associated with the same events when blockages were removed (Table 1).

RESULTS

The amount of blockage in each subreach of the study varied substantially; 550 cu m in subreach I and 71,133 cu m in subreach II. This debris comprised approximately 0.03 and 16 percent, respectively, of the total original channel volume in each subreach. The influence of recent drainage and clearing by private landowners in subreach I is evident from the relatively small amount of debris found there.

Changes in flood stages or water surface elevations (WSEL) between pre- and postrenovation conditions (Table 2) indicated that the most notable stage reductions were correlated with subreaches where the most extensive blockages were removed. Prerenovation versus post-renovation WSEL's were projected to differ by tenths of a centimeter in subreach I for 2-, 5-, and 10-year storm events and nearly 12 centimeters in subreach II for a 10-year storm event. Renovation should increase the

Table 1.--Values used for hydraulic coefficients associated with pre- and postrenovation channel obstruction conditions on the Deep Fork River, Lincoln County Oklahoma (Values drived from Chow 1959, U.S. Army Corps of Engineers 1982, and Shields and Nunnally 1984).

Blockage Model (aerial view)	Manning's Roughness (n)[1]	Contraction (K_c)	Expansion (K_e)
(Prerenovation)			
	.15	.4	.8
	.15	.4	.8
	.15	.3	.8
	.15	.2	.8
(Postrenovation)			
blockage removed	.04	.12[2]	.3[2]

Direction of Flow

[1]Manning's roughness coefficient assumes typical logjam surface roughness.

[2]These values represent averages used in U.S. Army Corps of Engineers water surface profile calculations.

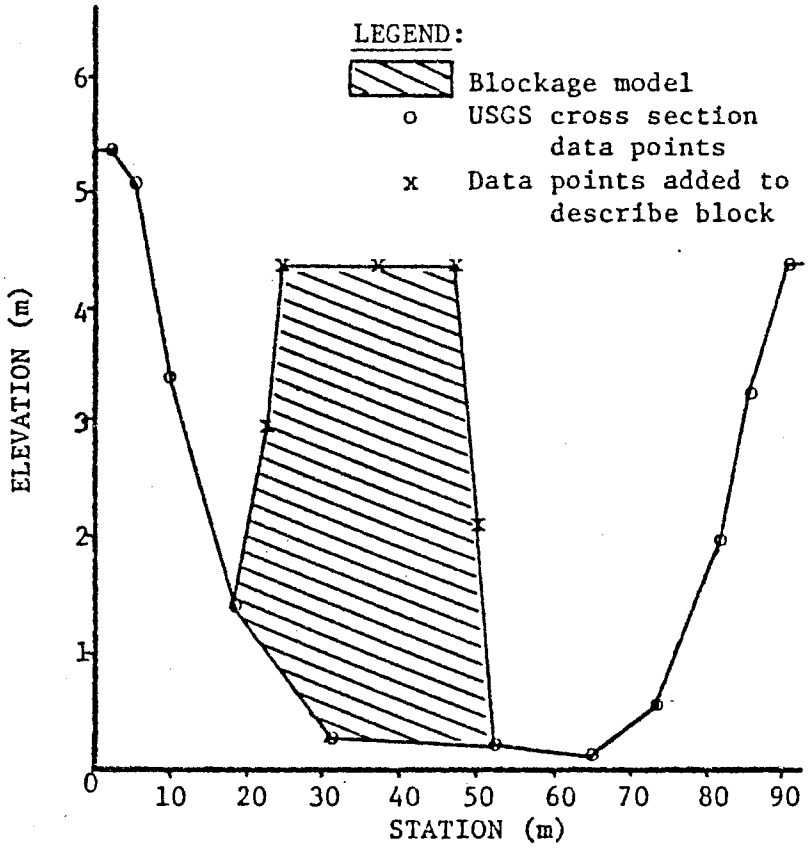


Figure 3.--A representative stream cross section at a blockage site in the Deep Fork River, Lincoln County Oklahoma.

Table 2.--Projected flood stage reductions resulting from simulated partial renovation (blockage removal) of the Deep Fork River channel, Lincoln County, Oklahoma.

Average Frequency Storm	Subreach	Stage Reduction[1] (cm)
2-year ($261\ m^3/s$)	I	0.6
	II	4.8
5-year ($566\ m^3/s$)	I	0.3
	II	9.8
10-year ($793\ m^3/s$)	I	0.3
	II	11.9

[1]Stage Reduction = Prerenovation stage - Postrenovation stage

reductions in flood stage at higher discharge values, but the effect would become proportionally smaller between the 5- and 10-year frequency floods. The small 2-year frequency flood crest would be reduced by 4.8 cm in subreach II and would be almost confined within the existing channel banks. The increased flood stage of a 5-year frequency storm would be decreased by 9.8 cm.

DISCUSSION

Field measurements and hydraulic information were shown to be useful for modeling channel obstructions. The size of the obstruction removed was positively related to the magnitude of flood stage reduction. Also, larger floods, e.g., a 10-year frequency storm, would overtop the blockages suggesting that blockage removal is less effective as a flood stage reduction tool for larger storm events. However, blockage removal overall will dislodge sediments and wash them downstream. Subsequent increased channel capacity and discharge rates will provide a reduced flood crest and period of flooding.

The limited flood stage reduction observed in this simulation is attributable to the fact that the old, i.e., channelized Deep Fork channel being renovated now lies within the wide overbank area and becomes relatively insignificant for calculation of total flood conveyance. Nonetheless, the methodology may have application in floodplains which contain major blockages in the primary channel.

Simulation of renovation further indicated that channel improvement, in addition to blockage removal, probably would be necessary in this

study area to reestablish the former channel. In some locations, field data showed channel capacity reduced by more than 50% from sediment deposition and, in these areas, sediment removal would be required. Simulation of sediment removal from those problem sites could indicate where limited resources could be expended to obtain the greatest return.

The study demonstrated that quantification of the hydraulic effects of stream obstructions is possible. Quantification should provide a clearer perception of flow problems and a better grasp of problem solving strategies. One application would be to determine which blockages, when removed, would provide the greatest immediate improvement in drainage and/or would reduce flood hazards to life or property.

The HEC-2 program would further allow the planner to simulate the effect upon channel capacity resulting from reestablishing original or new meanders on the Deep Fork. The former technique is being considered to overcome channel capacity problems for the channelized Kissimmee River in Florida (Maranto 1984).

Models allow us to make predictions of the effects of channel improvements. Accurate prediction in designing stream renovation projects is critical to reduce costs and avoid further destruction of waterways. Accurate prediction also is important to allow us to incorporate environmental considerations with planning for stream improvements and larger flood control channel projects (Maranto 1984, McConnell 1979, Anonymous 1980, Shields and Palermo 1982, Shields and Nunnally 1984).

Our study was designed to determine if channel renovation, specifically blockage removal, could be substituted for channelization to help solve flood flow problems in the Deep Fork River. The study revealed that the following refinements would improve the predictability obtained from the model.

1) Determine the effect of using precise rather than representative field measurements for blockages when generating water surface profiles.

2) Determine whether more detailed and extensive field data, or simpler average values for parameters such as roughness, give more realistic projections of flood profiles.

3) Test the model for blockage removal on streams where blockages are a problem for drainage and stream flow in the principal channel.

4) Simulate the effect on WSEL's resulting from removal of sediments in highly obstructed channel reaches.

CONCLUSION

This study was designed to allow us to model the effect of removing channel blockages on flood stage reduction. The model revealed that removal of blockages on the Deep Fork River resulted in only slightly reduced flood stages, and that additional renovation would be required to reestablish obstructed portions of the original channel. The

methodology would appear to have important application in streams where blockages are the main impediment to flood water drainage.

ACKNOWLEDGEMENTS

We wish to recognize the professional and financial support provided by the Oklahoma State University Center for Water Research and the Department of Zoology, as well as the Oklahoma Cooperative Fish and Wildlife Research Unit. We are most appreciative of many other individuals, including Mr. Bruce Wilson, who contributed their thoughts, revisions and editing skills to this effort. Above all, the continual encouragement and patience shown by Mr. Donald Spurrier, P.E., of OSU Engineering Extension made this paper possible.

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CHAPTER II

LANDOWNER SURVEY INVESTIGATING RENOVATION AS A STREAM MANAGEMENT TOOL

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Abstract.--Support for renovation, rather than proposed channelization of the Deep Fork River in Oklahoma, was investigated among floodplain landowners. Land-use problems associated with poor floodplain drainage were identified as were four public groups supporting three stream improvement approaches and a no action approach. Groups were characterized by their attitudes toward environmental, agricultural, and developmental riverine resources. Support for stream improvement by renovation slightly exceeded that for either channelization approach, and little support existed for a no action approach. Developing local renovation projects appears feasible and publicly acceptable.

INTRODUCTION

Alternative approaches to conventional flood control and stream improvement projects are available. Techniques such as stream renovation, rehabilitation, or selective clearing and snagging--here collectively called renovation--have provided improved drainage capabilities in streams with flow problems (12,21). These techniques also offer biological and aesthetic benefits not usually associated with earlier stream improvement approaches (19,22).

Renovation techniques have been little used on large rivers (21) instead being limited to lower gradient waterways (8,17,20). Renovation projects have been implemented at costs from one-tenth to one-third that of nearby channelization projects (5). These facts, coupled with the growing trend toward a reduced number of large channelization projects and fewer federal sources of project monies, could eventually make stream renovation a widely used stream management approach for state and local governments.

These governments need planning tools for new stream management techniques to implement local water resource projects. Social surveys are one tool that can help bridge a critical gap between the resource planner and local interest groups. The importance of involving a local population in resource planning includes the following:

1) planners in cooperation with the public can reach common goals and objectives (24);

2) a range of acceptable solutions can be determined (6); potential project beneficiaries are more apt, therefore, to receive the benefits intended them by planners (24);

3) population segments or "publics" in opposition to proposed options can be identified (9) and conflicts potentially resolved (15). Likewise, publics with common interests can be identified and then allowed to work cooperatively (24);

4) the water resource and its associated local floral and faunal communities can be better identified and subsequently maintained; and

5) potential success of a project can be better guaranteed if the planning process includes open communication and public support-building from the onset (15). Thus, a sense of ownership and personal commitment to project goals can be initiated and perpetuated.

In 1984 and 1985, I used a mail questionnaire to determine and evaluate local public acceptance of, and cooperation in, a potential stream renovation project. Specific objectives included: 1) to identify and measure the severity of stream related problems encountered by the landowners, 2) to identify major public groups associated with a variety of stream improvement options, 3) to characterize the values and attitudes held in common by the major public groups, and 4) to identify the type of support available from renovation project proponents.

STUDY AREA

The study area was comprised of privately owned floodplain land along the Deep Fork branch of the North Canadian River and involved as respondents those people owning or leasing floodplain property within Lincoln and Creek Counties, Oklahoma. The Deep Fork begins near Oklahoma City and flows eastward, until it drains into Lake Eufaula near Henryetta in Okmulgee County. The 272 sq km (105 sq mi) watershed is located in the oak-bluestem parkland ecoregion (4) and incorporates portions of Oklahoma, Logan, Lincoln, Creek, Okfuskee, and Okmulgee Counties.

The Deep Fork, in all but Lincoln County, consists of a relatively unmodified channel with a well-timbered floodplain. However, the river was channelized in Lincoln County during the period 1912 to 1923 (11). Subsequent intensive cotton farming and timber clearing, among other land uses within the watershed, led to severe soil erosion, buildup of excessive channel debris, loss of channel capacity, and long-term inundation of the Lincoln County floodplain. Although cropland and

pasture have been lost, overflow problems have been offset by fishing, hunting, and other recreational opportunities (10).

Numerous means have been used or proposed to control flooding along the Deep Fork (7). Flood control studies have been authorized recently by Congress (1). Plans currently under study involve a number of features including channelizing 56 km (35 mi) of the river, extending the Arkansas River Navigation Channel along the Deep Fork to Arcadia Lake, building hydroelectric power facilities, and providing additional recreation areas and irrigation. Renovation is not being considered as an alternative for channelization. In this study I examined the local public response to renovating the Deep Fork River.

METHODS AND MATERIALS

Survey Design

The primary population of interest for this study was landowners and their tenants along the Deep Fork in Lincoln and Creek Counties. Deep Fork landowners within Creek County were surveyed to investigate response variability created by local political boundaries, differences in floodplain resources, and past stream management decisions.

Floodplain boundaries were identified on U. S. Geological Survey quadrangle maps, and floodplain areas were divided into one square mile sections. An ownership list was prepared and compared against tax receipt records maintained at County Treasurer Offices in Lincoln and Creek Counties. Three hundred seventy-four taxpayers owning property

within the floodplain boundaries were identified and considered potential questionnaire respondents.

A pilot study was conducted on August 23, 1984, to evaluate the effectiveness of the survey instrument and to predict the extent of response. A six page mail-questionnaire (Appendix C), accompanied by a stamped, return-addressed envelope and a cover letter (Appendix B) bearing an Oklahoma State University, Department of Zoology letterhead was mailed to 30 individuals within each of the two counties. Modifications for improved readibility and clarity in instructions were made on the basis of results from the pilot survey.

A second and final survey instrument was mailed on October 9, 1984, to the remaining 209 and 108 floodplain landowners in Lincoln and Creek Counties, respectively. A reminder postcard (Appendix D) was mailed on November 2, 1984 to the 182 and 97 nonrespondents identified respectively in each county. No steps were taken to determine the percent of undeliverable responses. Returns from the pilot and final survey were pooled. Each was given an identifying code number and responses were coded.

Survey Content and Testing

The written questionnaire was organized into five sections, four of which are reported herein. These sections, and specific tests conducted subsequently, included:

1) demographic information including questions regarding the respondent's location of residence relative to the floodplain, and the

total floodplain acreage owned or leased, occupation, age, and income class.

2) past and present floodplain landuse by the respondent including problems and successes; response choices were scaled (3) to determine the degree of problems and successes encountered. The relationship between land-use problems and inadequate floodplain drainage was tested.

3) landowner's preferences for various stream system management alternatives including an owner's acceptance of conventional channelization or renovation. Respondents ranked Deep Fork River improvement options from most to least desirable and, based on the results, were grouped into four major "publics." These publics were characterized, using bivariate testing, according to their demographic features and their valuation of floodplain resources. These resources were categorized as Environmental, Agricultural and Developmental and respondents were given scaled choices for determining resource value.

4) examination of respondents supporting renovation to determine their willingness to cooperate in a variety of suggested renovation features.

Statistical data analyses were accomplished using Statistical Package for the Social Sciences (18). Analyses included one-way frequency distributions, chi-square tests of significance, tests for association using Cramer's V, and rank-order correlations including Spearman's rho (r_S) and Kendall's tau. Percents based on frequency

distributions were adjusted to exclude nonresponses. Tests for the relationship between variables were considered significant at the 95% level of probability.

RESULTS AND DISCUSSION

Eleven pilot survey forms were returned from each county for equal return rates of 37%. Final survey responses were obtained from 105 (50%) and 42 (39%) of the potential respondents, respectively. Following elimination of incomplete or incorrectly answered surveys, a grand total of 107 (45%) and 45 (33%) returns were useable including pilot survey responses (Appendix E).

General Description of Respondents

There were significant ($P = 0.004$) but weak ($V = 0.33$) differences in landowner income between counties (Table 1). Lincoln County respondents (67%) annually earned less than $30,000, whereas 66% in Creek County earned more than $30,000. Compared to Lincoln County, Creek County respondents tended to contain a slightly higher percentage of state residents (Table 2), a higher percentage of nonresiding floodplain property owners (Table 3), and a higher percentage of individuals with land holdings larger than 100 acres (41 ha) (Table 4).

Full-time farming or ranching (Table 5) were more common among Lincoln County respondents (15%) then among those in Creek County (9%). The occupational differences may explain some of the differences in the owners' state and on-site residence preferences. Naturally, those

Table 1. Percent response to net income categories by Deep Fork survey respondents in Lincoln and Creek Counties, Oklahoma.

County	Income Category				
	less than $8,000 (%)	$8,000-$18,000 (%)	$18,001-$30,000 (%)	$30,001-$50,000 (%)	greater than $50,000 (%)
Lincoln (N = 99)	13.1	25.3	29.3	13.1	19.2
Creek (N = 39)	2.6	10.3	20.5	33.3	33.3
Both Counties* (N = 138)	10.1	21.0	26.8	18.8	23.2

*X^2 = 15.35, 4 d.f., P = 0.004; V = 0.33

Table 2. Percent response to place of residency by Deep Fork survey respondents from Lincoln and Creek Counties, Oklahoma.

County	N	In State (%)	Out of State (%)
Lincoln	107	84.1	15.9
Creek	45	80.0	20.0
Both Counties	152	83.0	17.0

Table 3. Percent response to type of land ownership by Deep Fork survey respondents from Lincoln and Creek Counties, Oklahoma.

County	Residing Owner (%)	Nonresiding Owner (%)	Lessee (%)	Residing Owner-Lessee (%)	Nonresiding Owner-Lessee (%)	Other (%)
Lincoln (N = 103)	36.9	45.6	3.9	5.8	4.9	2.9
Creek (N = 45)	26.7	64.4	0.0	4.4	2.2	2.2
Both Counties (N = 148)	3.8	51.4	2.7	5.4	4.1	2.7

Table 4. Percent response to surface area owned by Deep Fork survey respondents from Lincoln and Creek Counties, Oklahoma.

County	Surface Area Class (acres/hectares)				
	< 25 / < 10	25 - 50 / 10 - 20	51 - 100 / 21 - 41	101 - 320 / 41 - 130	> 320 / > 130
Lincoln (N = 103)	11.7	24.3	18.4	30.1	15.5
Creek (N = 42)	9.5	14.3	19.0	42.9	14.3
Both Counties (N = 145)	11.0	21.2	18.5	33.6	15.2

Table 5. Percent response to job category by Deep Fork survey respondents from Lincoln and Creek Counties, Oklahoma.

Job Category	County		
	Lincoln (%) (N = 103)	Creek (%) (N = 43)	Both Counties (%) (N = 146)
Farm or Ranch Full-time	14.6	9.3	13.0
arm or Ranch Part-time	15.5	16.3	15.8
Other Occupation	29.1	30.2	29.5
Retired	24.3	23.3	24.0
Farm or Ranch Part-time + Other Occupation	8.7	9.3	8.9
Farm or Ranch Part-time + Retired	4.9	2.3	4.1
Other Occupation + Retired	1.0	0.0	0.7
Other	1.9	9.3	4.1

individuals who farm their property are more apt to reside in the state and on their flooplain property. Respondents from both counties were fairly evenly distributed in most age classes (Table 6). Overall, the percenages for each class ranged from 11 to 17%, except that age class 58-63 contained 28% of the respondents. Respondents ranged from 30 to 88 years of age with 58 years being the mean.

Identification of Stream Related Problems

Fifty-four percent of Lincoln County respondents considered "Inadequate Drainage" a major problem and only 29% had experienced high success in "Maintaining Drainage Ditches." In contrast, 37% of Creek County respondents considered "Inadequate Drainage" a major problem, while 46% were successful in "Maintaining Drainage Ditches." Conclusions become difficult, though, if we find, for example, that a landowner indicated a major problem with a land-use item but he also indicated high success in managing that problem. Therefore, the questions regarding landowner problems (Table 7) and successes (Table 8) should be compared with caution.

There were notable problem differences in the percentages of responses for crop yields, livestock production, and inadequate drainage by county (Table 7). Sixty-six percent of the Lincoln County respondents had experienced either moderate or major problems with crop yields. In Creek County, the figure was only 39%. These numbers might suggest that poor crop yields in Lincoln County have resulted from differential drainage problems. However, crop yield might also be affected by differences in soil fertility, topography, or other factors. Chi-square tests revealed

Table 6. Percent response to age class by Deep Fork survey respondents from Lincoln and Creek Counties, Oklahoma.

County	Age Class					
	26 - 41 (%)	42 - 49 (%)	50 - 57 (%)	58 - 65 (%)	66 - 73 (%)	74 - 89 (%)
Lincoln (N = 105)	11.4	19.0	16.2	27.6	11.4	14.3
Creek (N = 44)	11.4	13.6	18.2	29.5	13.6	13.6
Both Counties (N = 149)	11.4	17.4	16.8	28.2	12.1	14.1

Table 7. Problems encountered on the Deep Fork River floodplain by landowners surveyed in Lincoln (L) and Creek (C) Counties, Oklahoma.

	Magnitude of Problem									
	Respondents (N)		None (%)		Slight (%)		Moderate (%)		Major (%)	
	L	C	L	C	L	C	L	C	L	C
Crop Yields	100	38	27	42	7	18	16	13	50	26
Pasture Development	99	40	32	35	17	18	22	20	28	28
Livestock Production	98	38	49	45	14	34	19	16	17	5
Inadequate Drainage	101	41	18	34	12	12	17	17	54	37

Table 8. Successes achieved on the Deep Fork River floodplain by landowners surveyed in Lincoln (L) and Creek (C) Counties, Oklahoma.

	Magnitude of Success									
	Respondents (N)		High (%)		Moderate (%)		None (%)		Doesn't Apply (%)	
	L	C	L	C	L	C	L	C	L	C
Raising Crops	100	42	26	52	32	19	40	29	2	0
Grazing Livestock	104	43	26	23	11	7	50	58	14	12
Maintaining Drainage Ditches	103	41	29	46	42	17	23	29	6	7
Building/ Maintaining Levees	101	42	41	69	33	12	24	17	3	2

significant differences between responses by county for crop yield problems ($P < 0.03$) and livestock production problems ($P < 0.03$) only, and not for differences in perceived drainage problems. Fifty-four percent of Lincoln County respondents considered inadequate drainage a major problem compared to 37% in Creek County.

Bivariate analyses showed all land-use variables with a significant lack of independence from the problem of inadequate drainage. Relatively strong, positive associations were shown only between the problem variables and the drainage variable. Respondents having a major problem with crop yields also considered inadequate drainage a major problem (Table 9). The highly significant correlations between drainage and the problem variables suggest that a measurement of problem magnitude is more statistically reliable than a measurement of success magnitude.

The localization of the occurrence of inadequate drainage throughout the study area was determined by controlling for county differences. A chi-square test of independence for inadequate drainage and pasture development problems remained significant for both Lincoln ($P < 0.00001$) and Creek ($P < 0.0001$) counties. The relationships between inadequate drainage and problems with crop yields and livestock production remained for Lincoln County ($P < 0.0001$ and $P < 0.00001$, respectively) but was insignificant for Creek. Floodwater drainage appears to have created more land-use problems for Lincoln County respondents than those in Creek County. This wasn't unexpected considering the extent of long-term flooding that has been occurring in the former. The latter tests for Creek County should be considered inconclusive, however, because the

Table 9. Relationship between the problem of inadequate drainage and other problem or success items as measured by contingency table analyses.

PROBLEM ITEM	Chi-square	df	Probability	Contingency Coefficient	Correlation Coefficient
Crop Yields	63.5	9	0.0000	0.56	0.55++ (N = 136)
Pasture Development	68.8	9	0.0000	0.58	0.53++ (N = 137)
Livestock Production	50.4	9	0.0000	0.52	0.49++ (N = 134)
SUCCESS ITEM					
Raising Crops	33.6	6	0.0000	0.35*	-0.17+ (N = 140)
Grazing Livestock	17.0	9	0.0485	0.33	-0.004 (N = 141)

*Cramer's V
+Significant at P < 0.05
++Significant at P < 0.01

small sample size for the county resulted in unreliable chi-square approximations.

We attempted to determine what each respondent would do with his land given an improvement in floodplain drainage. One particularly useful test compared the responses of those experiencing difficulty in pasture development with the responses for anticipated change in grazing opportunities. The relationship was highly significant (X^2 = 68.9, 9 df, P < 0.00001) and resulted in a highly significant correlation (tau = 0.55) nearly equivalent to that calculated for the pasture development-drainage test (Table 4). Moreover, the relationship remained and remained strong when controlled for differences between Lincoln (X^2 = 45.9, 9 df, P < 0.0001; tau = 0.54, P < 0.001) and Creek Counties (X^2 = 26.2, 9 df, P = 0.0019; tau = 0.59, P < 0.001).

Identification of Major Public Groups

Thirty-four percent of the respondents ranked two or more stream improvement options equally (Table 10). There responses were excluded from further analyses. This reduced potential interpretation biases but also reduced the total useable sample.

For each alternative in Table 10, the number of respondents assigning that alternative a ranking from one to four were weighted, summed and averaged. This approach provided a composite ranking (Figure 1) and revealed a number of key points:

Table 10. Stream improvement alternatives ranked* from least (1) to most desirable (4) by respondents of the Deep Fork River survey.

[ ]	Channelization for Navigation (i.e., channel widening, deepening, and straightening)
[ ]	Channelization not for Navigation (i.e., channel widening, deepening, and straightening)
[ ]	No Action (i.e., no concerted effort would be made to improve floodplain drainage or channel flow problems)
[ ]	Renovation (i.e., blockage removal, bank stabilization, and long-term maintenance)

*Note: no rank order is implied.

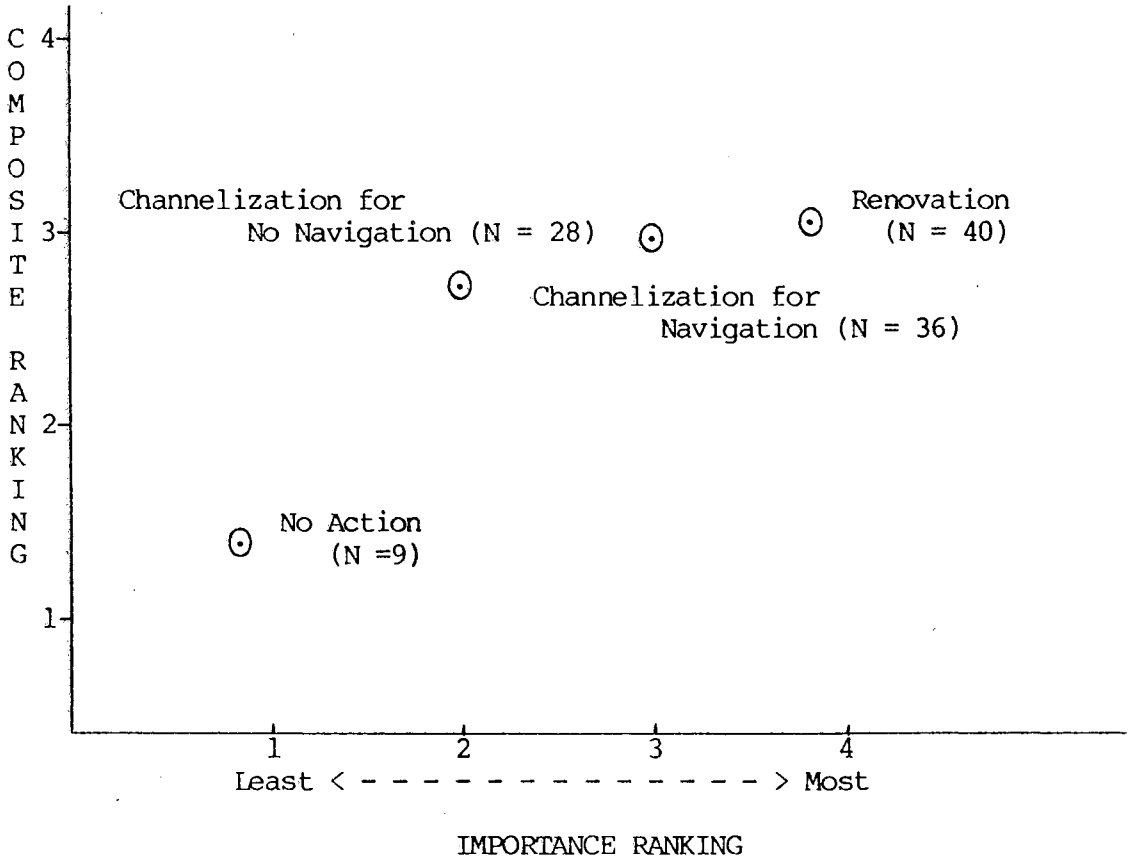

Figure 1. Composite ranking* of individual channel improvement alternatives for the Deep Fork River, Oklahoma. The N value indicates the number of respondents considering the alternative "Most Desirable."

*Alternative X Composite Ranking = $\frac{n_1(1) + n_2(2) + n_3(3) + n_4(4)}{n_1 + n_2 + n_3 + n_4}$

1) Respondents pooled from both counties preferred renovation, i.e., Renovators outnumbered both channelizer groups and the Nonsupporters[+].

2) Renovation and both channelization alternatives were associated with approximately equal composite rankings but the no action alternative had a markedly lower composite ranking.

3) Giving respondents two channelization choices that appeared mutually exclusive caused channelization to be ranked behind renovation. One might assume that because floodplain resources differed between counties (23), that the respondents might differ in the stream improvement option selected. In fact, when importance rankings were evaluated by county, responses from individuals in Lincoln and Creek were much the same. One difference was that in Creek County, renovation and channelization without navigation were ranked equally. This equality may represent the true distribution of respondents; however, the number of Creek County individuals responding to each stream improvement alternative in the survey was at or below the level (N = 30) considered statistically valid (N = 30).

[+]Supporters of each stream improvement alternative (Table 10), i.e., those respondents considering an alternative "most desirable," will be referenced subsequently as "Channelizers for Navigation," "Channelizers for No Navigation," "Nonsupporters," and "Renovators."

Characterization of Major Public Groups

Demographics

There were no significant relationships between location of residence, number of acres owned, occupation, age, or income and each of the four groups—Channelizers for Navigation, Channelizers for No Navigation, Renovators, and Nonsupporters. The highest percentages of respondents by occupation for each major public group were retired or employed in nonfarming or ranching professions. Full- and part-time farming or ranching together comprised about 30% of the respondents. No Nonsupporters were involved in either full- or part-time farming or ranching.

The income category of respondents appeared inversely related to the choice of stream improvement alternative. Most Channelizers for Navigation (27%) fell into the $8,000 to $18,000 annual income category. At the other extreme, most Nonsupporters (44%) earned more than $50,000 annually and none earned less than $18,000. Channelizers for No Navigation (39%) primarily fell into the $18,001 to $30,000 per year category, while most Renovators (34%) also earned more than $50,000 annually. Respondents in the lower income categories may have foreseen personal monetary benefits from stream improvement projects that maximize floodplain drainage and channel development (e.g., navigation). Monetary benefits may not have been important for respondents in the higher income categories. Renovators and Nonsupporters may have anticipated an increased tax burden on their floodplain property resulting from a channelization project. Taxes were considered a "Major

Problem" by 22% of both Renovators and Nonsupporters as compared to 13% and 3% of Channelizers for Navigation and Channelizers for No Navigation, respectively. A drainage tax was levied against the original Deep Fork landowners to finance the channelization project at the turn of the century (11).

Floodplain Resource Value Assessment: General Characterization of Respondents--

A similar percent of respondents for both channelizer groups and Renovators considered most of the Environmental (Figure 2) and Agricultural Resources (Figure 3) important. The lack of any large differences between these groups could suggest some similarity of goals and philosophies amongst these three groups. However, if we evaluated the way the groups ranked alternatives (Figure 4), Renovators were different than both channelizer groups for 5 of the 8 Environmental Resources.

The percent of Channelizers for Navigation valuing navigation as important (84%) far exceeded the percent of Channelizers for No Navigation (48%) and Renovators (36%) that valued these factors (Figure 5). Similarly, sixty-three percent of the Channelizers for Navigation thought hydroelectric power to be important as compared to 36% of the Renovators and 33% of Channelizers for No Navigation. Thus, development of navigation and hydroelectric power resources along the Deep Fork is strongly supported by only one public group surveyed, whereas relatively moderate support was given by the remaining groups. Even between the two channelization groups, notable differences in valuation of

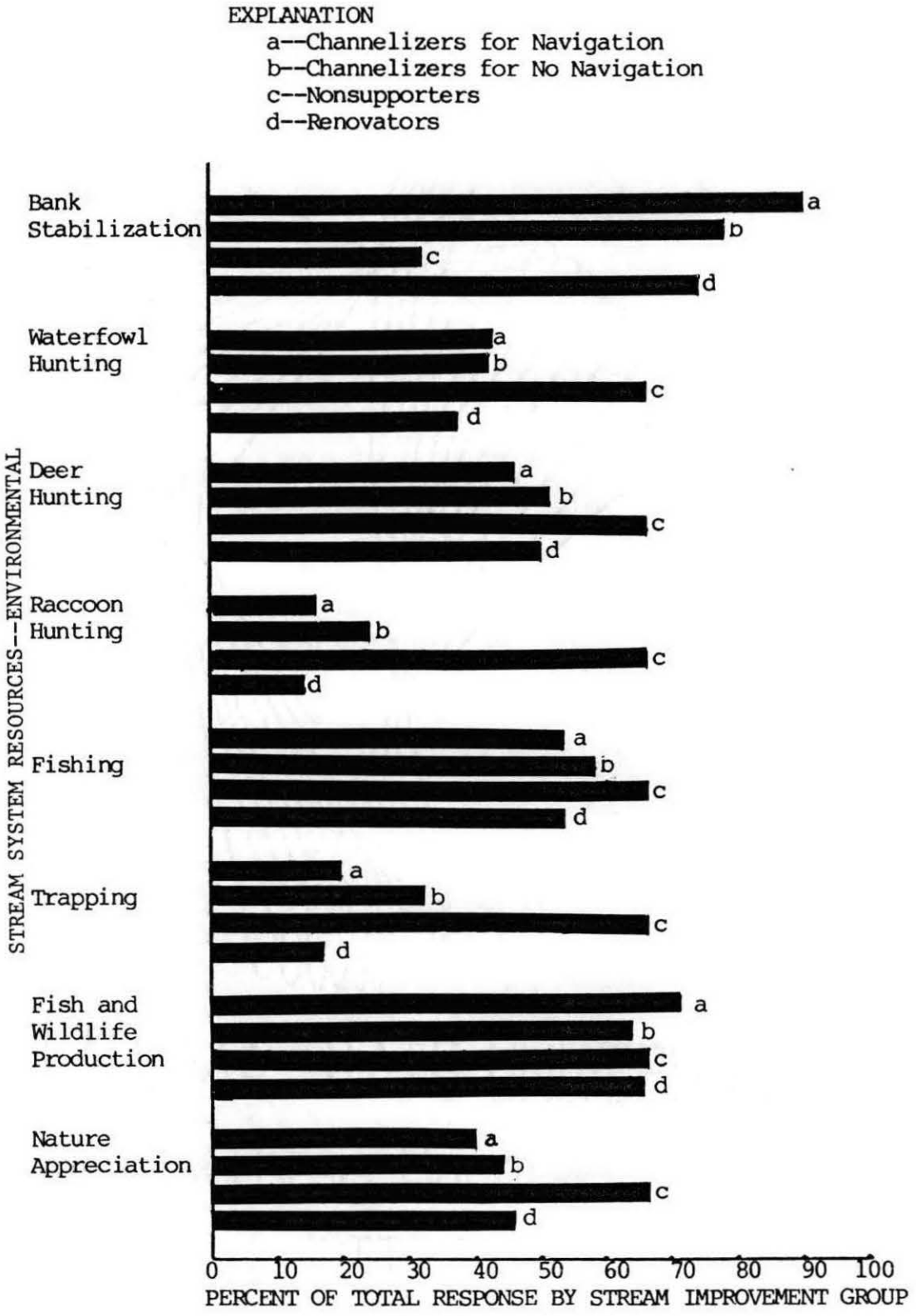

Figure 2. The percent of Deep Fork survey respondents (i.e., those ranking a stream improvement alternative "most desirable") considering an environmental stream system resource important.

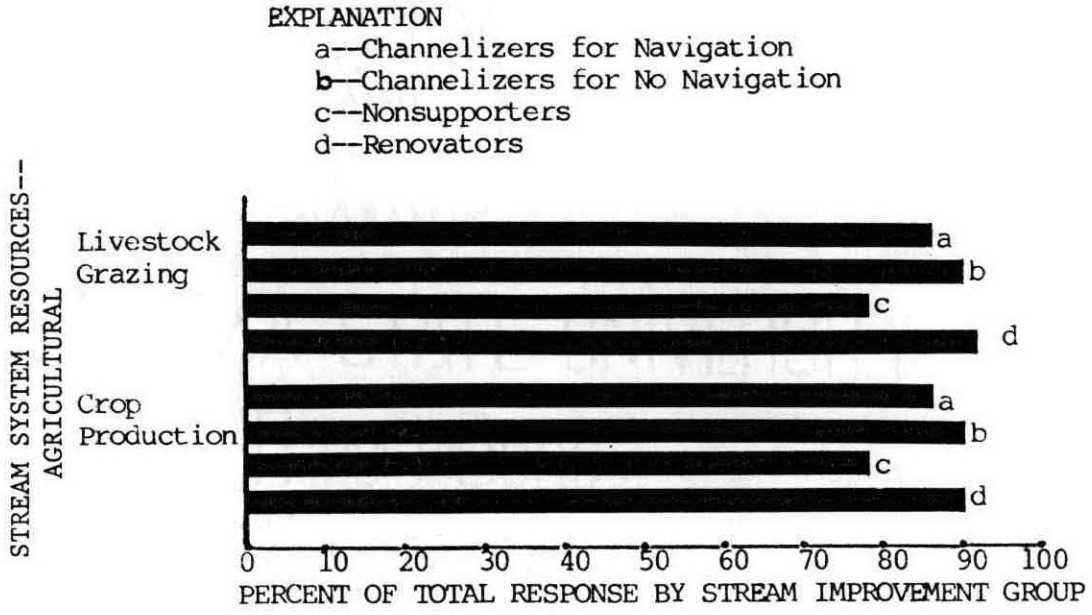

Figure 3. The percent of Deep Fork survey respondents (i.e., those ranking a stream improvement alternative "most desirable") considering an agricultural stream system resource important.

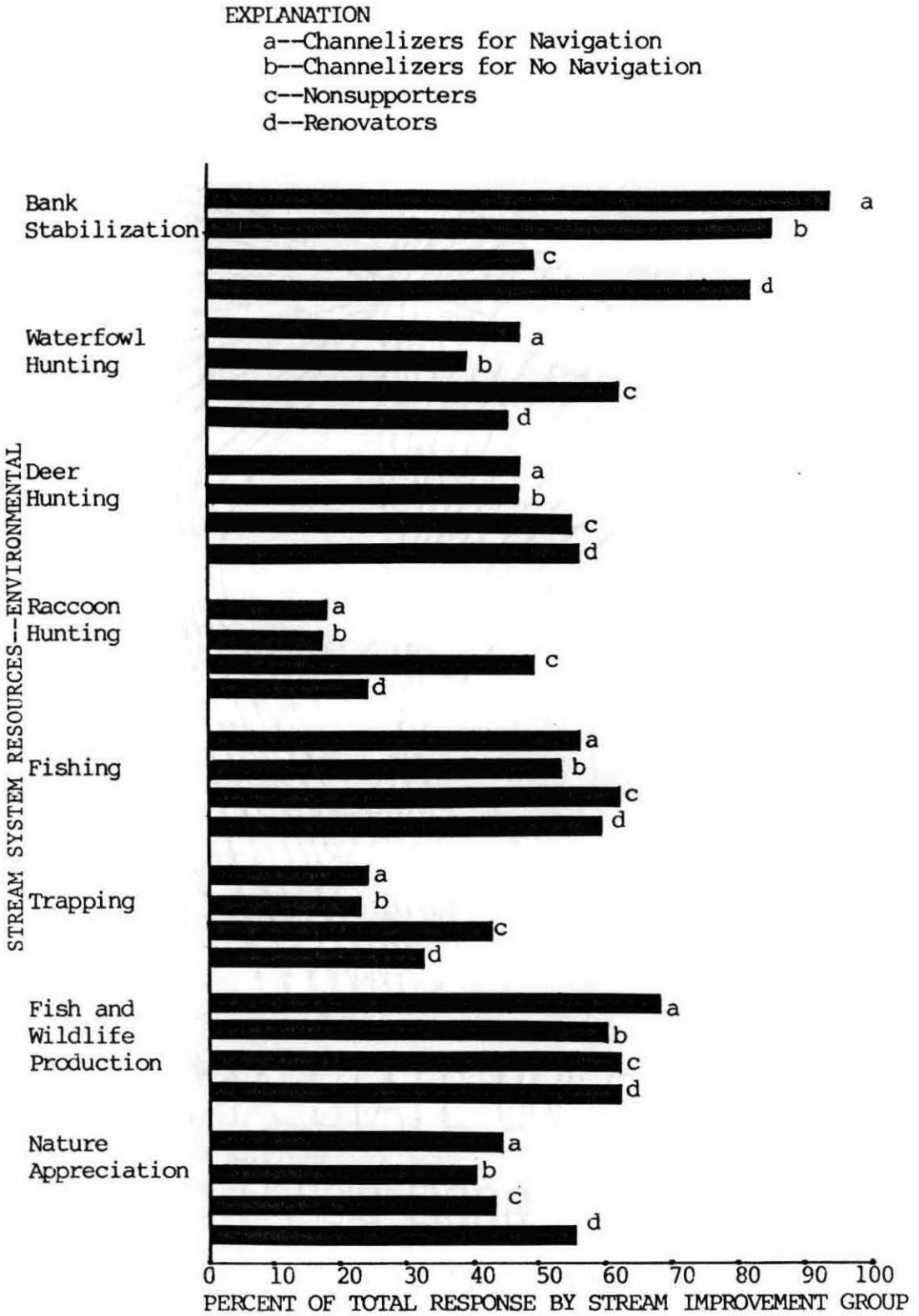

Figure 4. The percent of Deep Fork survey respondents (i.e., those ranking a stream improvement alternative "most" or "somewhat desirable") considering an environmental stream system resource important.

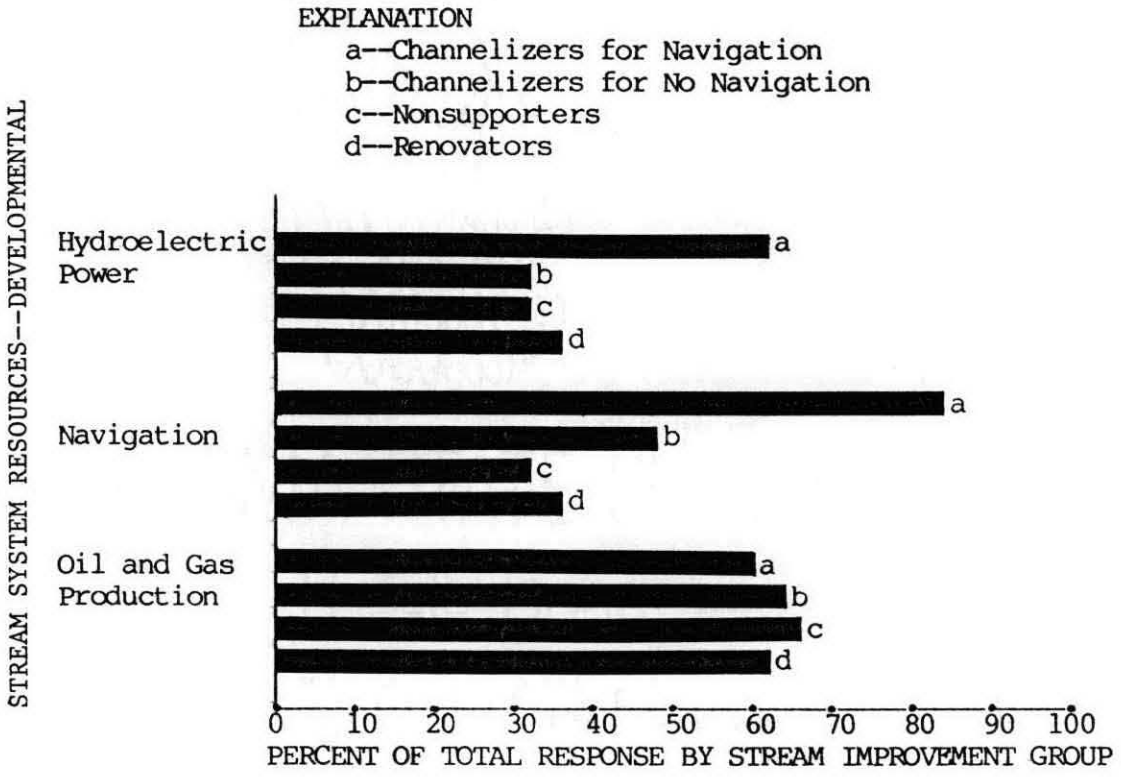

Figure 5. The percent of Deep Fork survey respondents (i.e., those ranking a stream improvement alternative "most desirable") considering a developmental stream system resource important.

hydroelectric power resulted. In the name of economic growth, water development proponents currently are studying such resource development for the Deep Fork (1), but concern for the immenseness of the studies has arisen (2). Results here suggest moderate support overall from riparian landowners for certain resource development.

Nonsupporters generally valued Environmental Resources higher than other groups (Figure 2). Nonsupporters may have viewed any stream improvement approach as a course for adversely impacting the resources they value highly. Thus, their support for a "No Action" approach might suggest real opposition, not ambivalence, to other approaches. However, five of the six highly valued Environmental Resources correspond to leisure time enjoyment. Since all Nonsupporters (N = 9) were either retired or not involved in any farming or ranching that was dependent on the Deep Fork River floodplain, their values appeared shaped less by a reliance upon the stream system (i.e., floodplain) for a livelihood and more for its environmental amenities.

Floodplain Resource Value Assessment: Specific Characterization of Respondents--

Channelizers for Navigation as a whole (Figure 6) and for Lincoln County had an overall preference ($P < 0.001$) for navigation. Fifty-seven percent (N = 21) considered navigation "very important." Sixteen percent (N = 6) considered navigation unimportant. Conversely, 52% (N = 14) of the Channelizers for No Navigation considered navigation unimportant. Only 15% (N = 4) considered it "very important." Channelizers for Navigation (Figure 6) had a preference for

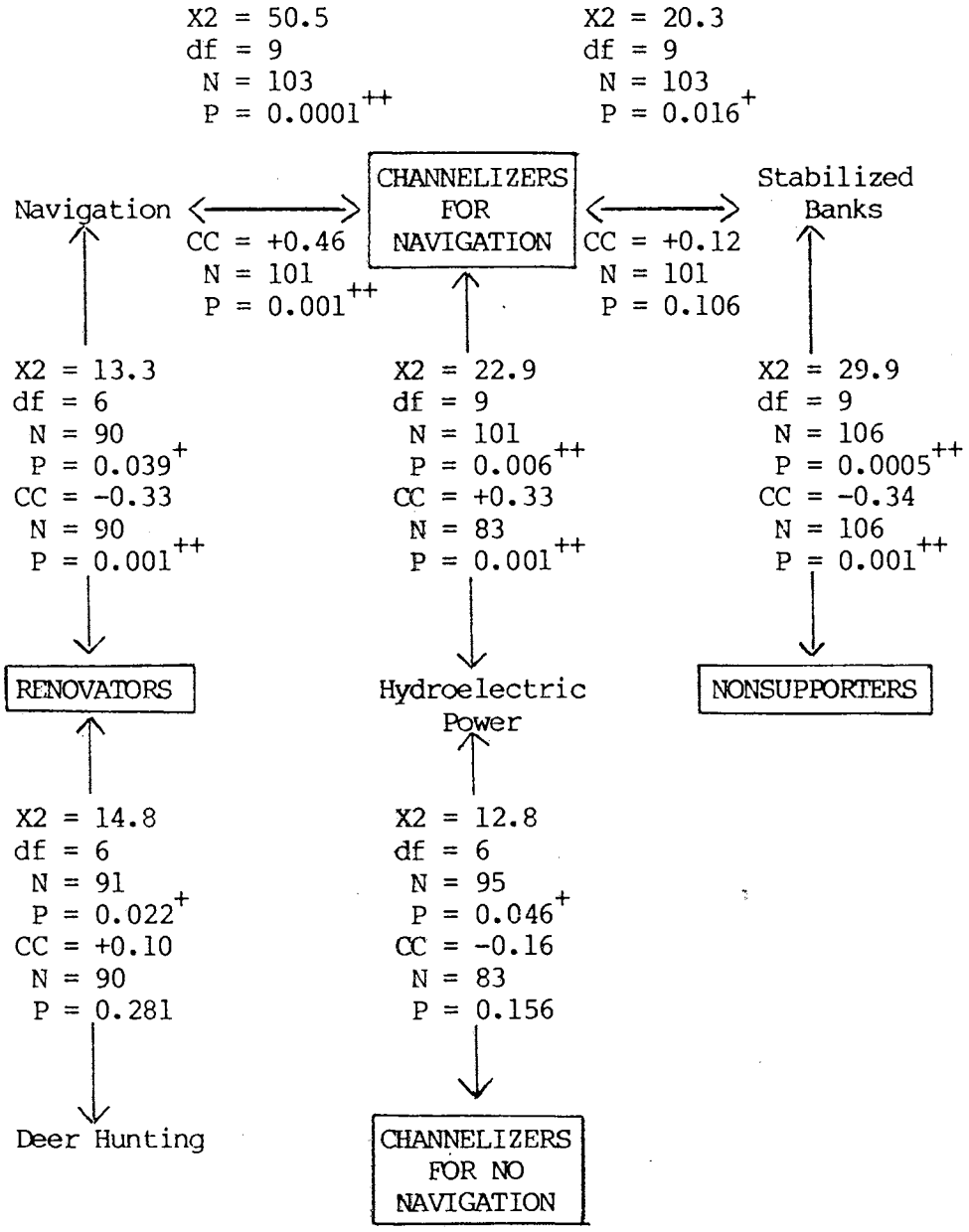

Figure 6. Relationships between the four major public groups (i.e., boxed items) in the Deep Fork River, Oklahoma, survey and selected floodplain resources ($^{+}$ = significant; $^{++}$ = highly significant).

hydroelectric power ($P < 0.001$). Channelizers for No Navigation showed a significant lack of independence ($P < 0.05$) with the hydroelectric power variable. However, unlike the positive correlation between the Channelizers for Navigation and hydroelectric power, the Channelizers for No Navigation were negatively but not significantly correlated ($r_s = -0.16$) with hydroelectric power.

Although Renovators appeared earlier to be basically similar to both channelizer groups relative to evaluation of Environmental (Figure 2) and Agricultural Resources (Figure 2 and 3), chi-square tests for independence indicated a significant relationship between preferences for deer hunting and Renovators (Figure 6). The biological sensitivity associated with a renovation approach to stream improvement (19), appeared to be held by deer hunters. This conclusion is in keeping with that of Kellert (13,14) who found an "ecologistic" attitude was high among hunters. Also, Renovators did not want ($P < 0.001$) navigation (Figure 6), and 54% ($N = 25$) considered hydroelectric power unimportant. Therefore, except for oil and gas production, where all major public groups were relatively equal in their value assessment, Renovators tended not to value Developmental Resources highly.

Channelizers for Navigation wanted ($P < 0.05$) stabilized stream banks (Figure 6). Either by a learned or an intuitive understanding, these individuals may have recognized that channel instability is an inherent feature of channelization projects (22). Nonsupporters did not consider stabilized banks ($P < 0.001$) or livestock grazing ($P < 0.007$) important.

Nonsupporters were shown earlier to be retired or occupationally removed from these floodplain resources.

Elaboration of the Renovator Profile

The necessary funding and work force for renovation projects, thus far, have been provided by Federal grants (8,16) and local governments (20). In this study, of the 62 respondents with some preference for renovation, 23% (N = 14) also were willing to offer financial support for a renovation project. Although no significant relationship existed between these Renovators and their income class, thirteen reported their income level and nine of those had incomes exceeding $50,000 annually.

Of the renovation supporters in the survey, 33% (N = 21) expressed a willingness to offer their own labor to implement a project. This expressed willingness was considerably greater from Lincoln County (40%) when compared to Creek County (19%). Recent drainage projects implemented in Lincoln County by local landowner groups may have encouraged comparative actions among Lincoln County respondents.

To date, successful renovation projects have depended on riparian property owners to extend voluntary rights-of-way agreements. Cooperation from landowners has been very good (8,20). In this survey, 66% (N = 97) of all respondents were willing to allow access to their floodplain property for implementing a renovation project. Renovators were only slightly more agreeable (71%, N = 45) than the other groups to allow access.

SUMMARY AND CONCLUSIONS

A questionnaire survey was administered to Deep Fork River floodplain landowners in Lincoln and Creek Counties, Oklahoma. The survey was designed to 1) identify and measure the severity of stream related problems encountered by the landowners, 2) identify major public groups associated with a variety of stream improvement options, and 3) characterize the values and attitudes held in common by the major public groups.

Identification of Stream Related Problems

The goals and objectives in any water resource management project generally are not common to all parties affected. More unanimity can be obtained by a clear statement of stream resource problems and a better perspective on the desires of the various publics. Our approach allowed us to accomplish these goals.

Bivariate analysis using contingency tables provided useful information for determining potential cause and effect relationships between drainage and land-use problems. Problems with crop yields, pasture development and livestock production were significantly related to the existence of inadequate floodplain drainage. Successes associated with raising crops and grazing livestock, on the other hand, were inversely related to inadequate drainage. The highly significant correlations between drainage and the problem variables, however, suggest that determining the magnitude of land-use problems is more statistically reliable than making inferrences from a determination of land-use successes.

On a county basis, results suggested that pasture development problems were attributed significantly to poor floodplain drainage in both Lincoln and Creek Counties. Problems with crop yields and livestock production also were statistically related to poor drainage but only in Lincoln County. This tendency toward between-county differences in flood related problems supports findings that Lincoln County respondents (54%) considered inadequate drainage a major problem as compared to those in Creek County (37%).

Land-use problems were further identified by examining a respondent's anticipated change in a land-use type given an improvement in floodplain drainage. Respondents in both Lincoln and Creek Counties indicated they would make a major change toward more pasture development given a reduction in flooding problems.

Identification of Major Public Groups

Allowing respondents to rank order three stream improvement approaches, plus the alternative to make no improvements, was useful in determining the strength of support for each approach by local "publics." Although useable responses were reduced in number, possibly as a result of respondents' inexperience with ranking, results clearly indicated a nearly unanimous support for approaches other than one of no action.

Overall support for the remaining approaches was fairly evenly distributed. Unless support for the two channelization approaches was combined, support for renovation slightly exceeded that for channelization with no navigation which, in turn, exceeded support for

channelization without navigation. This high support for renovation suggests that landowners now may prefer other stream improvement approaches to channelization. The numerous decades of frustration, hazard, and losses related to the original Deep Fork channel straightening project and its subsequent flooding may be recognized for its full impacts on the local environment. Also, respondents may have recognized that no stream improvement, regardless of its nature, provides long-term benefits unless it is accompanied by ongoing maintenance (12,20) as renovation would be.

Characteristics of Major Public Groups

No significant differences between public groups existed based on a variety of demographic characteristics. However, all respondents preferring a no improvement option for the Deep Fork were involved in occupations other than full- or part-time farming or ranching. These individuals would have little to risk by supporting a do nothing stream management approach as compared to those dependent upon their floodplain property for farming or ranching.

The income category of respondents appeared inversely proportional to the nature of a stream improvement alternative, e.g., those in the lower income categories supported channelization more than a less environmentally damaging renovation approach or one of no action, and vice versa.

Floodplain resources were valued differentially by the three non-renovation stream improvement groups: a) Nonsupporters, as a percent, exceeded all other public groups supporting most Environmental

Resources; b) Nonsupporters did not consider stabilized banks an important floodplain resource; c) Differences between the two channelization option groups were significant and supported the decision in this study not to consider them as one distinct group.

Elaboration of the Renovator Profile

Except for oil and gas production, Renovators tended not to highly value Developmental Resources, particularly navigation and hydroelectric power. Furthermore, Renovators tended to offer greater support for the Environmental Resources than either channelizer group. Some interest was shown among Renovators to help finance a renovation project, with a majority of the support resulting from those with annual incomes in excess of $50,000. This finding suggests possibilities for successfully developing local renovation projects. Further encouragement for local project feasibility was suggested by the considerable support shown by respondents (66%) supporting renovation who were willing to donate their labor and allow the necessary rights-of-way for completing a project.

The use of a questionnaire survey has been demonstrated in this project to be a valuable planning tool for identifying the overwhelming concern by Deep Fork floodplain landowners for flooding problems. Perhaps more importantly, the survey approach provided evidence that landowners have a concern for environmental resources on their floodplain. This is reflected further in their support for using a renovation approach to improve drainage problems.

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CHAPTER III

RIPARIAN LANDOWNER RESPONSE TO LAND-USE POLICIES AND INFRASTRUCTURES TO COMPLEMENT STREAM RENOVATION

ABSTRACT.--Floodplain landowners along the Deep Fork River in Oklahoma were solicited for their response to management and protection strategies as part of a potential long-term stream renovation project. Strong support existed for a local stream management board to address on-going problems and implement solutions. Cooperative efforts between private landowners and water management planning agencies was supported. Support for conservation easements exceeded that for state regulation to protect riparian communities. Economic incentives from tax savings had little influence on protection strategy preference except among those with financial problems. Preferred protection strategies varied across local political boundaries and could influence stream basin planning.

INTRODUCTION

Riparian ecosystems store flood waters, recycle nutrients, control erosion, abate water-borne pollutants, provide habitats for a diversity of floral and faunal species, and offer numerous opportunities for public recreation. Nevertheless, it has been estimated that nearly 70% of riparian habitats have been altered.[2] Fortunately, stream renovation, i.e., low impact channel maintenance, can help solve channel obstruction, flow, and drainage problems.[6,9,12,16,18] Renovation, when coupled with floodplain protection strategies, offers a sound alternative to the use of traditional channelization projects.

Floodplain protection provided by national policies further helps curb riparian losses. Examples of such national policies include Executive Order No. 11,990, 42 Fed. Reg. 26,961 (1977), Protection of Wetlands and the Clean Water Act, 33 U.S.C. 1251 et seq., section 404 (1977), which controls dredging and filling activities in aquatic ecosystems. Oregon and 11 eastern states provide some form of legal protection for their fresh water wetland ecosystems.[8] Most other states, however, have no apparent means of protecting riparian resources from modification by channelization, dewatering, logging operations, impoundment, urban encroachments or livestock and farming operations.

Most states do not have appropriate incentives to ensure maintenance of riparian resources. More importantly, state and local governments may lack a measure of public support for such maintenance. One valuable tool to make such a measure is the questionnaire survey which can help bridge a critical gap between resource planners and potentially affected local populations. Taylor[19] lists the importance of involving local populations in resource planning and policy development.

Attempts to enlist support from local groups and individual landowners within a renovation project area have been limited. Projects, thus far, have depended upon public cooperation only in order to establish necessary rights-of-way on streamside property.[6,13] McConnell et al. have suggested other possibilities, such as conservation easements, for public participation in renovation projects.

A questionnaire survey was administered in 1984 and 1985 to determine and evaluate local public acceptance of, and possible cooperation in, a potential stream renovation project. Specifically, I proposed to do the following:

1) identify respondents preferences for strategies to protect Deep Fork stream and riparian communities;

2) identify respondents preferences for an entity to administer and manage local Deep Fork River problems;

3) identify demographic traits of the survey respondents as related to preferences for stream system management and protection strategies.

STUDY AREA

The study area was comprised of privately owned floodplain land along the Deep Fork of the North Canadian River. Potential respondents were those people owning or leasing land within Lincoln and Creek Counties, Oklahoma. The Deep Fork, in all but Lincoln County, consisted of a relatively unmodified channel with a well-timbered floodplain. However, channelization of the river in Lincoln County during the period 1912 to 1923[5] led to timber clearing and intensification of agriculture. Further physiognomic description of the study area and vicinity is available elsewhere.[18,19]

Attempts in the early 1970's by the U.S. Fish and Wildlife Service to establish a national wildlife refuge to protect remaining bottomland

hardwood forests along the Deep Fork met with failure.[4] Other management and protection strategies have not been proposed. Increased riparian clearings for crops and livestock have continued.

METHODS AND MATERIALS

Three hundred seventy-four taxpayers owning property within the Deep Fork River floodplain boundaries in Lincoln and Creek Counties were identified and considered potential questionnaire respondents. The approach to the survey design, mailing strategy, and statistical analyses have been described fully by Taylor.[19] No steps were taken to determine the percent of undeliverable responses. Percents based on frequency distributions were adjusted to exclude nonresponses. Tests for the relationship between variables was considered significant at the 95% level of probability.

The written questionnaire was organized into five sections, two of which provided the results used in this report. These sections, and specified tests conducted subsequently, included the following:

1) demographic information including the respondent's location of residence relative to the floodplain, and the individual's total floodplain acreage, occupation, age, and income category;

2) landowner's preferences for suggested stream system management and protection alternatives including riparian legislation and conservation easements. Landowner preference for the suggested alternatives was tested against respondents' perception of selected land-use successes and problems as well as their valuation of selected

floodplain resources. Response differences between counties were tested. Tests included one-way frequency distributions, chi-square test of significance, assorted measures of association, and rank-order correlations.

RESULTS AND DISCUSSION

Eleven pilot survey forms were returned from each county for equal return rates of 37%. Final survey responses from Lincoln and Creek County were obtained from 105 (50%) and 42 (39%) of the potential respondents, respectively. Following elimination of incomplete or incorrectly answered surveys, a grand total of 107 (45%) and 45 (33%) returns were useable including pilot survey responses (Appendix E).

General Description of Respondents

There were significant ($P = 0.004$) but weak ($V = 0.33$) differences in landowner income between counties (Table 1). Lincoln County respondents (67%) annually earned less than $30,000, whereas 66% in Creek County earned more than $30,000. Compared to Lincoln County, Creek County respondents tended to contain a slightly higher percentage of state residents (Table 2), a higher percentage of nonresiding floodplain property owners (Table 3), and a higher percentage of individuals with property holding larger than 100 acres (41 ha) (Table 4). Full-time farming or ranching (Table 5) tended to be more common among Lincoln County respondents (15%) then among those in Creek County (9%). The occupational differences may explain some of the differences in the owners' state and on-site residence preferences. Naturally, those individuals who farm their property are more apt to reside in the state

Table 1. Percent response to net income categories by Deep Fork survey respondents in Lincoln and Creek Counties, Oklahoma.

County	Income Category				
	less than $8,000 (%)	$8,000-$18,000 (%)	$18,001-$30,000 (%)	$30,001-$50,000 (%)	greater than $50,000 (%)
Lincoln (N = 99)	13.1	25.3	29.3	13.1	19.2
Creek (N = 39)	2.6	10.3	20.5	33.3	33.3
Both Counties* (N = 138)	10.1	21.0	26.8	18.8	23.2

*X^2 = 15.35, 4 d.f., P = 0.004; V = 0.33

Table 2. Percent response to place of residency by Deep Fork survey respondents from Lincoln and Creek Counties, Oklahoma.

County	N	In State (%)	Out of State (%)
Lincoln	107	84.1	15.9
Creek	45	80.0	20.0
Both Counties	152	83.0	17.0

Table 3. Percent response to type of land ownership by Deep Fork survey respondents from Lincoln and Creek Counties, Oklahoma.

County	Residing Owner (%)	Nonresiding Owner (%)	Lessee (%)	Residing Owner-Lessee (%)	Nonresiding Owner-Lessee (%)	Other (%)
Lincoln (N = 103)	36.9	45.6	3.9	5.8	4.9	2.9
Creek (N = 45)	26.7	64.4	0.0	4.4	2.2	2.2
Both Counties (N = 148)	33.8	51.4	2.7	5.4	4.1	2.7

Table 4. Percent response to surface area owned by Deep Fork survey respondents from Lincoln and Creek Counties, Oklahoma.

County	Surface Area Class (acres/hectares)				
	< 25 / < 10	25 - 50 / 10 - 20	51 - 100 / 21 - 41	101 - 320 / 41 - 130	> 320 / > 130
Lincoln (N = 103)	11.7	24.3	18.4	30.1	15.5
Creek (N = 42)	9.5	14.3	19.0	42.9	14.3
Both Counties (N = 145)	11.0	21.2	18.5	33.6	15.2

Table 5. Percent response to job category by Deep Fork survey respondents from Lincoln and Creek Counties, Oklahoma.

Job Category	County		
	Lincoln (%) (N = 103)	Creek (%) (N = 43)	Both Counties (%) (N = 146)
Farm or Ranch Full-time	14.6	9.3	13.0
Farm or Ranch Part-time	15.5	16.3	15.8
Other Occupation	29.1	30.2	29.5
Retired	24.3	23.3	24.0
Farm or Ranch Part-time + Other Occupation	8.7	9.3	8.9
Farm or Ranch Part-time + Retired	4.9	2.3	4.1
Other Occupation + Retired	1.0	0.0	0.7
Other	1.9	9.3	4.1

and on their flooplain property. Respondents from both counties were fairly evenly distributed in most age classes (Table 6). Overall, the percentages for each class ranged from 11 to 17%, except that age class 58-63 contained 28% of the respondents. Respondents ranged from 30 to 88 years of age with 58 years being the mean.

Stream and Riparian Management and Protection Strategies

This report investigated the respondents' support for two management strategies, i.e. allowing a local board of individuals to administer long-term Deep Fork River maintenance and allowing a select entity or combination of entities to conduct channel clearing activities. The report further investigated the respondents' interest in protecting the Deep Fork either by state riparian legislation or conservation easements.

Management Strategies

Overall, a majority (66.3%) of respondents favored the creation of a local board and only 12.2% (N = 18) were opposed. Support for a board was strongest in Lincoln County (74%), where major flooding results from channel blockages. Opposition was greatest (25%) in Creek County. A chi-square test for independence indicated that the between county difference was significant ($P = 0.0028$). The degree of support for creation of a board was negatively correlated (tau = -0.1591, $P \leq 0.03$) to the degree of success in maintaining drainages. In a similar but more strongly associated relationship (tau = -0.2546), the degree of support for creation of a board was positively correlated ($P \leq 0.001$) to the extent of problems that respondents identified with inadequate drainage. Although this relationship was not significant when

Table 6. Percent response to age class by Deep Fork survey respondents from Lincoln and Creek Counties, Oklahoma.

County	Age Class					
	26 - 41 (%)	42 - 49 (%)	50 - 57 (%)	58 - 65 (%)	66 - 73 (%)	74 - 89 (%)
Lincoln (N = 105)	11.4	19.0	16.2	27.6	11.4	14.3
Creek (N = 44)	11.4	13.6	18.2	29.5	13.6	13.6
Both Counties (N = 149)	11.4	17.4	16.8	28.2	12.1	14.1

controlled for county, 85% of the Lincoln County respondents who considered inadequate drainage a "Major Problem," also favored creation of a local board. The same was true for only 60% of the Creek County respondents. Therefore, a respondent's proximity to inadequately drained floodplain property would appear to strongly influence their support for a Deep Fork River maintenance board.

Cairns, Stauffer, and Hocutt [3] proposed that elasticity in a natural system, i.e., its ability to recover from damage, depends partially upon management or organizational capabilities for controlling a damaged area. In this regard, the survey investigated landowner's perceptions of who actually should be responsible for clearing the Deep Fork channel (Appendix B, Part 3F). The survey possibilities included floodplain landowners, U. S. Army Corps of Engineers, county commissioners, State of Oklahoma, no one, or any combination thereof. Thirty-nine percent (N = 57) of all respondents indicated that responsibilities should be assumed cojointly by the Corps of Engineers and the state of Oklahoma. Only 15% favored the Corps assuming responsibility, and only 12% favored the Corps coupled with floodplain landowners.

The support for the Corps assuming some responsibility simply may reflect the understanding by respondents that the Corps must assume jurisdiction for navigable streams (See Natural Resources Defense Council v. Callaway, 392 F. Supp. 685, D.D.C. 1975), whereas the floodplain landowner has no legal responsibility for any flood control related stream management. Nonetheless, survey results might suggest a belief that landowners also should assume more responsibility. Few

respondents (3%, N = 4) felt that landowners alone should be responsible for keeping the Deep Fork channel clear. However, their interest in assuming such a responsibility increased to 12% when the responsibility was shared with the Corps of Engineers.

Protection Strategies

Stream protection strategies in this country include resource gifting, fee title acquisition, and zoning ordinances.[7] County zoning ordinances have been quite successful, for instance, in Arizona.[11] However, this Deep Fork River questionnaire survey was limited to investigating landowner support for riparian zone legislation and conservation easements and did not include county zoning.

Riparian Legislation. On a nationwide basis, state regulation of streams and streamside areas is usually a component of regulatory efforts applying to state waters and floodplains. Shoreline zoning programs have been adopted in Washington, Vermont, Maine, and Wisconsin[7] but support for a similar law in Oklahoma was mixed (Table 7). Forty percent showed some support for a state law but 46% opposed it. Some opposition to this law may reflect the traditional belief that the landowner "owns" the state's navigable waters, and a law would weaken that "ownership." An earlier survey[14] of Oklahoma's general populace indicated that 53% of respondents would favor a law protecting floodplain and riparian wildlife habitat, if such a law "did not interfere with private ownership rights". The absence of the latter clause in the Deep Fork survey question may have created ambiguity and

Table 7. Percent response by county and degree of support to the question: "Do you favor a law protecting the state's streams (including the Deep Fork) and adjacent native vegetation from alteration, clearing, and development?"

	Lincoln		Creek	
	N	%	N	%
Strongly favor	25	24	8	19
Tend to favor	18	17	8	19
Undecided	14	14	6	14
Tend to oppose	21	20	13	30
Strongly oppose	26	25	8	19

caused respondents to be less supportive of potential state legislation than expected.

A chi-square test for independence between a respondent's support for a state riparian law and their occupation was significant (P = 0.0087). Although the variables were not highly associated (V = 0.25796), a few trends were apparent. Respondents involved in farming full- or part-time tended to be more opposed (48%) to a riparian law than in favor (28.6%). In contrast, those either retired or involved in a nonagricultural occupation tended to favor (48.0%) such legislation over those opposing it (38.7%). Thus, individuals who were not dependent on their floodplain land for fulfilling their occupational needs appeared more favorable to laws designed to protect floodplain resources from alteration--alteration that often results from agricultural intensification.[17]

Respondent support for riparian legislation also was related to the importance that they associated with various floodplain resources.[19] Fifty-four percent (N = 45) of those who considered crop production very important also opposed protective legislation for stream and riparian zones. The relationship was significant (P = 0.031) but not strongly associated (V = 0.22808). On the other hand, of those who considered fish and wildlife production very important (N = 44), more than 61% tended to favor or strongly favored a law to protect the state's riparian ecosystems. The relationship was highly significant (X^2 = 28.9698, 12 d.f.; P = 0.004). A test for a relationship between a respondent's occupation and his valuation of fish and wildlife

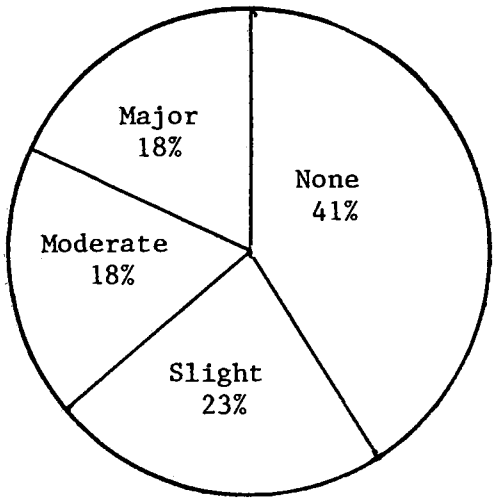
production did not show a significant relationship, but individuals (30%) in nonagricultural jobs tended to value this resource more than either full-time (14%) or part-time (21%) farmers and ranchers.

Conservation Easements. Easement agreements between landowners and state or local governments can benefit landowners as well as protect stream and riparian resources. Individuals may gain income tax advantages by donating conservation easements and restrictions on their riparian property to governmental bodies, publicly supported charities, or private charitable foundations.[7] More Deep Fork floodplain landowners (45.7% vs. 40.1%) favored a conservation easement program (Table 8) then a law (Table 7) to protect stream and riparian resources. Increased support for an easement program may have been due to the landowner's continued right to control access and to use the land and water. An easement also may offer a tax incentive for riparian protection. However, potential tax savings appeared to make little difference in respondent support for either protection strategy (Figure 1).

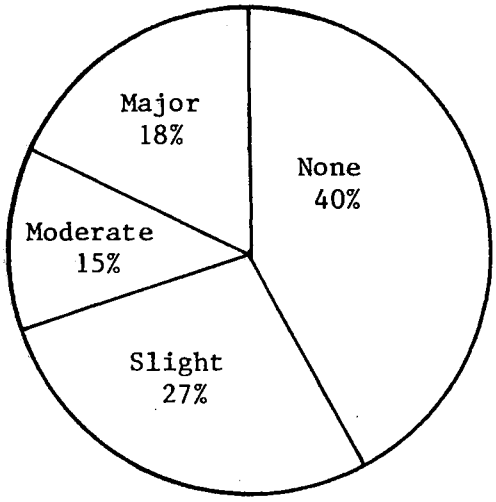
Only 32% of the state's general populace favored tax incentives for riparian landowners,[14] but 56% (N = 79) of all respondents in this Deep Fork survey considered floodplain property taxes to be at least a slight problem. Of those, nearly 60% (N = 40) were in favor of a conservation easement on their property. Similarly, 46% (N = 37) of respondents dissatisfied with their economic return favored a conservation easement. Only 18% of the same group opposed such an easement. Therefore, it appears that a high percentage of Deep Fork landowners would support a

Table 8. Percent response by county and degree of response to the question: "Would you favor a conservation easement that protects the riparian zone adjacent to your stream? Under Federal income tax law, such an easement would entitle a landowner to an income tax deduction while simultaneously allowing continued access control and use of the land and water.

	Lincoln		Creek	
	N	%	N	%
Strongly favor	31	29	6	14
Tend to favor	20	19	12	27
Undecided	34	32	12	27
Tend to oppose	3	3	0	0
Strongly oppose	18	17	14	32



RIPARIAN PROTECTION BY STATE REGULATION



RIPARIAN PROTECTION BY CONSERVATION EASEMENTS

Figure 1. The percent of survey respondents noting varying degrees of taxation problems on their Deep Fork floodplain property, and the influence of those problems on respondent's support for stream and riparian protection via state regulation or conservation easements.

conservation easement both for its resource protection features and economic merits.

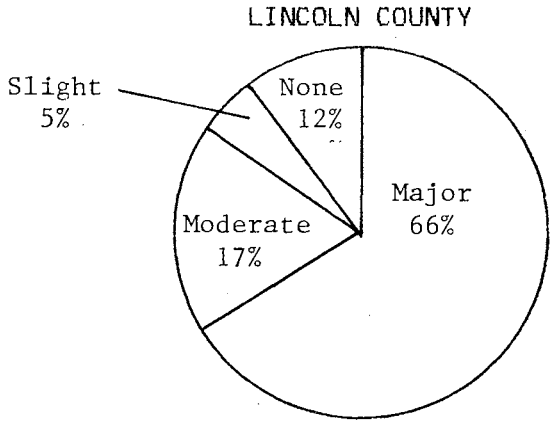
Modified easements allow for restricted tax deductions but provide other benefits to landowners. A timber easement program associated with a renovation project in western Tennessee provided lateral drainage privileges to floodplain property owners contingent upon their participation in conserving and protecting bottomland hardwood forest.[10] With this in mind, Deep Fork landowners were queried about their willingness to participate in a similar program, i.e., given drainage priveleges in exchange for maintaining protective fencing in the riparian zone (Table 9). Lincoln and Creek County responses indicated significant differences ($P \leq 0.0068$) in landowner support for a drainage-fencing easement with stronger support arising from Lincoln County respondents. These between-county differences are probably the result of differences in flooding problems (Figure 2), i.e., less support for a drainage-fencing easement would be expected from Creek County where flooding is less persistent.

The impacts of uncontrolled livestock on riparian habitats have been well documented.[1,15] Therefore, fencing likely would be an important component of any easement program on the Deep Fork, since 52% and 67% of the respondents in Lincoln and Creek Counties, respectively, used their land to pasture livestock.

Table 9. Percent response by county and degree of support to the question: "If lateral drainage-ways were constructed and maintained on your floodplain property (at no expense to you), would you be in favor of maintaining streamside fencing as an exchange?"

	Lincoln		Creek	
	N	%	N	%
Strongly favor	40	38	7	16
Tend to favor	22	21	8	18
Undecided	34	32	17	39
Tend to oppose	0	0	2	5
Strongly oppose	10	9	10	23

$X^2 = 14.16326$, $P = 0.0068$; $r_s = 0.2684$, $P = 0.001$



X2 = 21.53, 9 df, P = 0.0105; tau = 0.27, P = 0.002

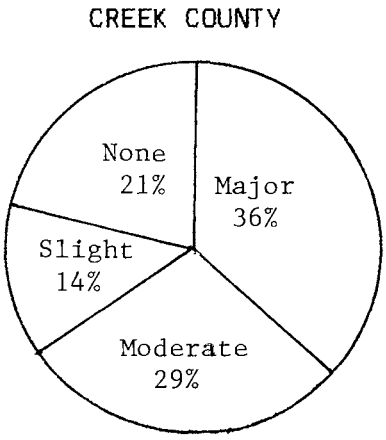


Figure 2. The percent of Deep Fork survey respondents in Lincoln and Creek Counties, Oklahoma, favoring a drainage-fencing easement and perceiving varying degrees of drainage problems on their floodplain property.

SUMMARY AND CONCLUSIONS

Respondents in Lincoln County, Oklahoma, (which contains a severely mismanaged stream but no stream management infrastructure) expressed strong support for a local stream management board. This "board" possibly could be patterned after those already administering county drainage and conservation programs.

Overall, respondents in Lincoln and Creek Counties were reluctant to assume control of stream management responsibilities but did support cooperative efforts with water planning-management agencies such as the U.S. Army Corps of Engineers. Cooperative efforts could lead to an increased efficiency in addressing localized stream problems, e.g., obstructed flows, bank erosion, and riparian habitat losses.

Support for riparian protection legislation was mixed, probably because landowners fear infringement upon private ownership. Therefore, any potential state regulations should be sensitive to landowner values and rights.

Farmers and ranchers who depend upon valuable floodplain resources for their livelihood tended to be more opposed to riparian protection regulations then retired individuals or those employed in nonagricultural occupations. Individuals who valued riparian resources for their fish and wildlife production capabilities offered significantly greater support for protection legislation then those who did not.

The support of respondents for conservation easements was greater than that for a riparian protection law. The retention of property rights likely explains this difference. An additional appeal of easements may lie with their economic incentives. Although between each of the groups supporting riparian legislation and conservation easements very little difference in taxation problems was experienced, easements were supported most by a majority of respondents who were discontented with property taxes and economic returns. This indicates that within a stream basin, political boundaries might separate differences in floodplain resources, land-use preferences, and problems. Riparian management and protection strategies may have to be customized to match these differences. For example, results of this study indicated significantly more support for a drainage-fencing easement within Lincoln County than in Creek County. Support was greatest where there were persistent severe flooding problems. The advantages of a drainage-fencing easement in Lincoln County would include: 1) improved floodplain drainage for participating landowners, 2) avoidance of drainage where flooded conditions are preferred, e.g., for recreational interests, 3) reduction in further riparian forest destruction, and 4) potential tax advantages for compliance. Such an easement program already has been successful elsewhere.[10]

Comprehensive stream management should not end on streambanks following application of any of a number of renovation techniques. Long-term stream system integrity can be better insured against natural and man-made perturbations by incorporating riparian protection and management strategies. Few methods for developing such strategies in areas with

riparian modifications and losses have been developed. State and local governments may need input from survey instruments which elicit riparian landowner's perspectives. Preferences for certain strategies can be identified, thus making implementation more effective, particularly in stream basins where local resource differences exist.

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APPENDICES

APPENDIX A.

DESCRIPTION OF MODELED CHANNEL OBSTRUCTIONS LOCATED ON THE DEEP FORK RIVER, LINCOLN COUNTY, OKLAHOMA

Obstruction No.	Stream Reach No.	Dimensions (meters)	Geometric Shape (Plan View)
1	1	12.0 X 14.5 X 2.0	Rectangle
2	1	4.0 X 4.0 X 1.5	Square
3	1	4.0 X 5.0 X 8.0 X 2.0	Triangle
4	2	2.0 X 3.0 X 1.5	Rectangle
5	2	4.0 X 16.0 X 3.0	Rectangle
6	2	20.0 X 20.0 X 1.0	Square
7	2	14.0 X 14.0 X 2.0	Square
8	2	5.0 X 16.0 X 1.5	Rectangle
9	2	16.0 X 16.0 X 1.5	Square
10	2	50.0 X 16.0 X 1.5	Rectangle
11	2	75.0 X 15.0 X 2.0	Rectangle
12	2	25.0 X 17.0 X 2.0	Rectangle
13	2	100.0 X 23.0 X 1.5	Rectangle
14	2	100.0 X 25.0 X 1.5	Rectangle

APPENDIX B.

COVER LETTER ACCOMPANYING THE

DEEP FORK RIVER SURVEY

OKLAHOMA STATE UNIVERSITY
Department of Zooology
430 Life Sciences West
Stillwater, Oklahoma 74078
(405)624-5555

October 4, 1984

Dear landowner:

Your association with the Deep Fork River, as owner, lessee and/or taxpayer of floodplain land, makes you well aware of the problems on portions of the river. In efforts to determine short and long-term solutions for Deep Fork maintenance and management, I have been studying the river and those people with whom it directly affects.

Attached is a questionnaire to determine your general attitudes, problems, and land-use preferences as they relate to the Deep Fork. Information gathered from this survey will provide benefits in the following ways:

1) in finding solutions to your current land-use - river conflicts and

2) in improving the decision making capabilities of appropriate individuals and groups at both private and governmental levels who are concerned with the Deep Fork.

Your participation in this survey is completely voluntary. You do not have to answer questions, if you do not wish. However, since your name has been selected from manhy landowners along the river, your cooperation in finding workable solutions on the Deep Fork becomes very important. All responses made will be strictly confidential. Only myself, the researcher, will have access to the list of names of those completing this survey. This list will be destroyed when all qustionnaires have been returned to my office.

I am interested in YOUR responses only. Answer as honestly and completely as possible leaving no question blank. Each question has instructions or is self-explanatory. There are no right or wrong answers. The questionnaire will take only 10-15 minutes of your time.

For your convenience I have enclosed a stamped, addressed return envelope. Please answer and return the questionnaire as soon as possible. By doing so, solutions for Deep Fork River problems can be addressed more quickly and with your concerns in mind.

APPENDIX B. CONTINUED

If you have any further questions or interests, please contact Robert Maples at the location below or myself at the location printed at the top of this page.

Sincerely,

Thomas J. Taylor

Robert Maples
Soil Conservation Service
710 Manvel, P.O. Box 529
Chandler, OK 74834
ph. (405)258-1405

APPENDIX C.

DEEP FORK RIVER OKLAHOMA SURVEY FORM AND FREQUENCY DISTRIBUTION OF USABLE RESPONSES

PART 1. QUESTIONS ABOUT USE OF YOUR OWNED OR LEASED DEEP FORK RIVER FLOODPLAIN PROPERTY

A. How have you used Deep Fork River floodplain land in the past? (circle Yes or No for EACH one of the following items)

	Lincoln				Creek			
	Yes		No		Yes		No	
	N	%*	N	%	N	%	N	%
1. Unimproved pasture	66	62	41	38	29	67	14	33
2. Oil/gas production	31	31	70	69	16	38	26	62
3. Improved pasture	37	35	69	65	18	42	25	58
4. Recreation	26	27	72	74	16	38	26	62
5. Crop production (Please specify type: _____)	61	57	46	43	17	40	26	61
6. Other (please specify: _____)	8	8	99	93	5	12	38	88

B. How are you presently using the land on the Deep Fork River floodplain? (circle Yes or No for EACH one of the following items)

	Lincoln				Creek			
	Yes		No		Yes		No	
	N	%	N	%	N	%	N	%
1. Unimproved pasture	55	52	50	48	20	46	24	55
2. Oil/gas production	28	30	66	70	16	38	26	62
3. Improved pasture	29	28	76	72	25	58	18	42
4. Recreation	25	27	68	73	15	37	26	63
5. Crop production (please specify type: _____)	41	39	65	61	13	30	30	70
6. Idle	28	27	75	73	9	21	34	79

APPENDIX C. CONTINUED

7. Other (please specify:_____)	10	9	96	91	3	7	41	93

C. For each of the following, do you foresee any change in use of your land if flooding decreases on the Deep Fork River flood? (circle ONE number for EACH item 1 through 5)

	No Change		Slight Change		Moderate Change		Major Change	
	N	%	N	%	N	%	N	%
1. Recreation								
Lincoln	58	59	20	20	11	11	9	9
Creek	23	55	9	21	7	17	3	7
2. Grazing								
Lincoln	33	33	15	15	24	24	28	28
Creek	13	32	9	22	9	22	10	24
3. Crop production								
Lincoln	37	36	5	5	18	17	44	42
Creek	19	46	1	2	8	20	13	32
4. Oil/gas development								
Lincoln	78	82	5	5	4	4	8	8
Creek	32	78	6	15	3	7	0	0
5. Other								
Lincoln	38	84	0	0	3	7	4	9
Creek	13	72	1	6	1	6	3	17
(please specify:_____)								

APPENDIX C. CONTINUED

PART 2. QUESTIONS ABOUT YOUR MANAGEMENT OF AND GOALS FOR OWNED OR LEASED DEEP FORK RIVER FLOODPLAIN PROPERTY

A. How much of a problem do you have with EACH of the following as they apply now to YOUR floodplain property? (circle ONE number for EACH item 1 through 9)

	No Problem		Slight Problem		Moderate Problem		Major Problem	
	N	%	N	%	N	%	N	%
1. Trespass								
Lincoln	31	31	39	39	16	16	14	14
Creek	9	22	17	42	10	24	5	12
2. Crop yields								
Lincoln	27	27	7	7	16	16	50	50
Creek	16	42	7	19	5	13	10	26
3. Inadequate drainage								
Lincoln	18	18	12	12	17	17	54	54
Creek	14	34	5	12	7	17	15	37
4. Livestock production								
Lincoln	48	49	14	14	19	20	17	17
Creek	17	45	13	34	6	16	2	5
5. Taxes								
Lincoln	42	43	19	19	19	19	19	19
Creek	19	46	13	32	7	17	2	5
6. Pasture development								
Lincoln	32	33	17	17	22	22	28	28
Creek	14	35	7	17	8	20	11	28
7. Soil loss								
Lincoln	33	34	26	27	21	21	18	18
Creek	16	41	8	21	7	18	8	21
8. Poaching								
Lincoln	49	51	27	28	12	12	9	9
Creek	13	32	8	20	10	25	9	23
9. Pollution								
Lincoln	39	43	20	22	10	11	22	24
Creek	20	53	8	21	6	16	4	10
(please specify type: _____)								

APPENDIX C. CONTINUED

B. On your floodplain land along the Deep Fork River, how much success have you had in EACH of the following activities? (circle ONE number for EACH item 1 through 7)

	High Success		Moderate Success		No Success		Doesn't Apply	
	N	%	N	%	N	%	N	%
1. Maintaining drainage ditches								
Lincoln	6	6	24	23	43	42	30	29
Creek	3	7	12	29	7	17	19	46
2. Leasing for recreation								
Lincoln	2	2	2	2	16	16	82	80
Creek	1	2	2	5	9	21	30	71
3. Raising crops								
Lincoln	2	2	42	40	33	32	27	26
Creek	0	0	12	29	8	19	22	52
4. Building/maintaining levees								
Lincoln	3	3	24	24	33	33	41	41
Creek	1	2	7	17	5	12	29	69
5. Grazing livestock								
Lincoln	14	14	52	50	11	11	27	26
Creek	5	12	25	58	3	7	10	23
6. Enjoying personal recreation								
Lincoln	19	19	31	31	10	10	40	40
Creek	7	17	17	41	4	10	14	33
7. Taking no management action								
Lincoln	10	11	21	22	13	14	47	52
Creek	4	11	8	22	3	8	22	59

APPENDIX C. CONTINUED

C. Water control structures (i.e. flood gates) provide an opportunity to drain and regulate water levels on flooded land. This can be beneficial for both agriculture and fish and wildlife. Would you be in favor of having such a structure on your floodplain land?

	Lincoln		Creek	
	N	%	N	%
1. Strongly favor	31	30	8	19
2. Tend to favor	31	30	11	26
3. Undecided	23	22	11	26
4. Tend to oppose	9	9	5	12
5. Strongly oppose	9	9	7	17

D. How important to you are EACH of the following present or possible items along the Deep Fork River? (circle ONE number for EACH item 1-17)

	Not Important		Slightly Important		Moderately Important		Very Important	
	N	%	N	%	N	%	N	%
1. Hydroelectric power								
Lincoln	61	61	14	14	9	9	16	16
Creek	22	52	4	10	9	22	7	17
2. Waterfowl hunting								
Lincoln	56	55	16	16	14	14	16	16
Creek	20	47	11	26	5	12	7	16
3. Erosion control								
Lincoln	12	11	5	5	28	27	60	57
Creek	6	14	5	12	11	26	21	49
4. Deer hunting								
Lincoln	53	52	20	19	16	16	14	14
Creek	17	41	9	21	8	19	8	19
5. Oil/gas production								
Lincoln	46	45	20	19	16	16	14	14
Creek	14	33	2	5	12	29	14	33

APPENDIX C. CONTINUED

	Not Important		Slightly Important		Moderately Important		Very Important	
	N	%	N	%	N	%	N	%
6. Raising crops (row, hay, fruit, nut)								
Lincoln	10	10	6	6	21	20	68	65
Creek	9	21	9	21	9	21	16	37
7. Grazing livestock								
Lincoln	14	13	6	6	22	21	63	60
Creek	6	14	6	14	10	23	22	50
8. Scientific investigation								
Lincoln	44	43	19	19	16	16	23	23
Creek	18	45	5	13	10	25	7	18
9. Nature appreciation/ photography/hiking								
Lincoln	61	60	14	14	10	10	17	17
Creek	19	45	9	21	6	14	8	19
10. Trapping								
Lincoln	73	72	19	19	7	7	3	3
Creek	30	71	7	17	2	5	3	7
11. Fishing								
Lincoln	47	46	16	16	20	19	20	19
Creek	15	36	10	24	10	24	7	17
12. Flood water storage								
Lincoln	37	36	21	20	13	13	33	32
Creek	17	41	7	17	9	21	9	21
13. Stabilizing banks								
Lincoln	15	15	12	12	18	18	58	56
Creek	11	26	6	14	6	14	20	47
14. Raccoon hunting								
Lincoln	76	74	11	11	10	10	6	6
Creek	32	76	6	14	1	2	3	7
15. Water purification								
Lincoln	39	38	8	8	16	16	40	39
Creek	13	30	8	19	10	23	12	28

APPENDIX C. CONTINUED

	Not Important		Slightly Important		Moderately Important		Very Important	
	N	%	N	%	N	%	N	%
16. Fish/wildlife production								
Lincoln	38	37	9	9	21	20	35	34
Creek	14	33	7	16	12	28	10	23
17. Navigation (barges, large boats, etc.)								
Lincoln	42	41	17	17	14	14	30	29
Creek	23	54	6	14	7	16	7	16

E. Do you favor a law protecting the state's streams and adjacent natural vegetation from alteration, clearing, and development? (This would include the Deep Fork River.)

	Lincoln		Creek	
	N	%	N	%
1. Strongly favor	25	24	8	19
2. Tend to favor	18	17	8	19
3. Undecided	14	14	6	14
4. Tend to oppose	21	20	13	30
5. Strongly oppose	26	25	8	19

PART 3. QUESTIONS ABOUT IMPROVEMENT OF THE DEEP FORK RIVER

A. Portions of the Deep Fork River are subject to frequent, severe and long-term flooding. When all factors of economics, environment and people are considered, how would you rank each of the following stream alteration methods based on which would provide a most desirable remedy? (Inside the [ ], rank the following as 1, 2, 3 or 4, giving each a different number. A 1 ranking is the MOST desirable remedy and a 4 is the LEAST desirable)

APPENDIX C. CONTINUED

[ ] 1. Channelization (i.e. channel widening, deepening, and straightening) FOR navigation)

	Most Desirable		Somewhat Desirable		Somewhat Undesirable		Least Desirable	
	N	%	N	%	N	%	N	%
Lincoln	25	35	15	21	21	29	11	15
Creek	11	33	4	12	13	39	5	15

[ ] 2. Channelization (i.e. channel widening, deepening, and straightening) with NO navigation included)

	Most Desirable		Somewhat Desirable		Somewhat Undesirable		Least Desirable	
	N	%	N	%	N	%	N	%
Lincoln	18	26	34	49	16	23	1	1
Creek	10	35	11	38	6	21	2	7

[ ] 3. No action

	Most Desirable		Somewhat Desirable		Somewhat Undesirable		Least Desirable	
	N	%	N	%	N	%	N	%
Lincoln	4	5	4	5	5	7	64	83
Creek	5	17	3	10	2	7	20	67

[ ] 4. Renovation (i.e. removal of blockages, bank stabilization, and long-term maintenance)

	Most Desirable		Somewhat Desirable		Somewhat Undesirable		Least Desirable	
	N	%	N	%	N	%	N	%
Lincoln	29	47	13	21	20	32	0	0
Creek	10	33	11	37	8	27	1	3

APPENDIX C. CONTINUED

B. If periodic "clean up" of the Deep Fork River channel were done locally, which of the following would you be willin to offer in cooperation? (circle Y (Yes) or N (No) for one or more of the following)

	Yes		No	
	N	%	N	%
1. Tractor or dozer				
Lincoln	28	27	77	73
Creek	10	24	32	76
2. Boat				
Lincoln	5	5	100	95
Creek	1	2	41	98
3. Financial support				
Lincoln	37	36	67	64
Creek	10	24	31	76
4. Access				
Lincoln	72	69	32	31
Creek	24	57	18	43
5. Labor				
Lincoln	40	38	65	62
Creek	12	29	30	71
6. Not interested (circle Y)				
Lincoln	16	15	NA	NA
Creek	15	36	NA	NA

C. One approach to protect and maintain a stream and its associated vegetation would be to establish a conservation easement zone adjacent to the stream. Under federal income tax law, such an easement would entitle the landowner to a deduction on their income tax. Furthermore, you could continue to control access, and use the land and water. Would you favor such an easement?

	Lincoln		Creek	
	N	%	N	%
1. Strongly favor	31	29	6	14
2. Tend to favor	20	19	12	27
3. Undecided	34	32	12	27
4. Tend to oppose	3	3	0	0
5. Strongly oppose	18	17	14	32

APPENDIX C. CONTINUED

D. Fencing is a useful way to protect streamside vegetation from alteration. If lateral drainage-ways were constructed and maintained on your floodplain land (at no expense to you), would you be in favor of maintaining streamside fencing as an exchange?

	Lincoln		Creek	
	N	%	N	%
1. Strongly favor	40	38	7	16
2. Tend to favor	22	21	8	18
3. Undecided	34	32	17	39
4. Tend to oppose	0	0	2	5
5. Strongly oppose	10	9	10	23

E. Would you like to see a body of appointed or elected LOCAL individuals formed (like the Conservation District Board), whose sole purpose is to administer long-term stream maintenance for the Deep Fork River?

	Lincoln		Creek	
	N	%	N	%
1. Strongly favor	38	37	5	11
2. Tend to favor	39	38	16	36
3. Undecided	20	19	12	27
4. Tend to oppose	2	2	3	7
5. Strongly oppose	5	5	8	18

F. WHO do you think should be responsible for keeping the Deep Fork River channel clear? (circle no more than TWO numbers)

	Lincoln		Creek	
	N	%	N	%
1. Floodplain landowners	2	2	2	5
2. Corps of Engineers	13	13	8	18

APPENDIX C. CONTINUED

		Lincoln		Creek	
		N	%	N	%
3.	No one	3	3	3	7
4.	County commissioners	1	1	0	0
5.	State of Oklahoma	4	4	1	2
6.	State of Oklahoma & Oil Companies	1	1	0	0
7.	Landowners & Corps of Engineers	12	12	5	11
8.	Landowners & County Commissioners	7	7	1	2
9.	Landowners & State	1	1	1	2
10.	Corps of Engineers & County Commissioners	8	8	3	7
11.	Corps of Engineers & State of Oklahoma	41	40	16	36
12.	County Commissioners & State of Oklahoma	8	8	2	5
13.	Other (please specify: _____)	1	1	0	0

PART 4. QUESTIONS ABOUT RECREATION ON YOUR OWNED OR LEASED DEEP FORK RIVER FLOODPLAIN PROPERTY

A. How much do you favor EACH one of the following recreational opportunities as they apply to your property and management preferences?

APPENDIX C. CONTINUED

	Strongly Favor		Mildly Favor		Mildly Oppose		Strongly Oppose	
	N	%	N	%	N	%	N	%
1. Personal hunting (i.e. family/friends)								
Lincoln	68	65	26	25	3	3	7	7
Creek	32	74	5	12	4	9	2	5
2. Personal fishing								
Lincoln	70	67	27	26	1	1	6	6
Creek	32	78	6	15	2	5	1	2
3. Leased hunting								
Lincoln	11	11	24	24	21	21	45	45
Creek	9	23	14	35	3	8	14	35
4. Public hunting								
Lincoln	2	2	3	3	15	15	82	80
Creek	3	7	5	12	5	12	28	68
5. Public fishing								
Lincoln	3	3	10	10	15	15	74	73
Creek	4	10	8	20	3	8	25	63
6. Personal trapping								
Lincoln	20	20	29	28	20	20	33	32
Creek	7	18	10	26	5	13	16	42

B. Are you satisfied with the economic return resulting from your floodplain property?

	Lincoln		Creek	
	N	%	N	%
1. Very satisfied	2	2	1	2
2. Satisfied	10	10	12	28
3. Undecided	13	13	7	16
4. Disatisfied	31	30	10	23
5. Very Disatisfied	36	35	3	7
6. Doesn't apply	10	10	10	23

APPENDIX C. CONTINUED

C. Many Oklahoma landowners earn extra money from waterfowl hunting leases. Owners retain full ownership and management rights of their land. Would YOU be interested in making your overflow land available for such a system?

	Lincoln		Creek	
	N	%	N	%
1. Very interested	8	8	4	9
2. Slightly interested	18	17	7	16
3. Undecided	9	9	8	19
4. Not interested	54	52	15	35
5. Wouldn't apply	15	14	9	21

D. If you were to make your Deep Fork River overflow land available through a hunting lease arrangement, what would you consider a fair return for its use? (circle one or more of the appropriate numbers and fill in the blank if necessary)

	Lincoln		Creek	
	N	%	N	%
1. ____ per hunter per day				
$ 5	4	4	1	2
12	1	1	0	0
25	3	3	1	2
50	1	1	0	0
75	0	0	1	2
No Response	98	92	42	93
2. ____ per hunting party per day				
$ 12	0	0	1	2
30	1	1	0	0
45	1	1	0	0
100	1	1	0	0
No Response	104	97	44	98

APPENDIX C. CONTINUED

	Lincoln		Creek	
	N	%	N	%
3. ____ per hunting club per season				
$ 50	1	1	0	0
150	1	1	0	0
200	2	2	0	0
500	1	1	0	0
1000	1	1	1	2
2000	0	0	1	2
2500	0	0	1	2
4000	1	1	0	0
No Response	100	94	41	93
4. A nonmonetary return				
Yes	3	3	2	2
No	104	97	44	98
5. Not interested				
Yes	56	52	23	51
No	51	48	22	49
6. Doesn't apply				
Yes	22	21	6	13
No	51	48	39	87
7. Other (please specify:_____)				
Yes	7	7	5	11
No	100	94	40	89

PART 5. QUESTIONS ABOUT YOURSELF (ALL your answers are STRICTLY CONFIDENTIAL)

A. What is your state of residency?

County	N	In State (%)	Out of State (%)
Lincoln	107	84.1	15.9
Creek	45	80.0	20.0
Both Counties	152	83.0	17.0

APPENDIX C. CONTINUED

B. What is your relationship to Deep Fork River floodplain land? (circle one or more numbers that applies)

County	Land Ownership Type					
	Residing Owner (%)	Nonresiding Owner (%)	Lessee (%)	Residing Owner-Lessee (%)	Nonresiding Owner-Lessee (%)	Other (%)
Lincoln (N = 103)	36.9	45.6	3.9	5.8	4.9	2.9
Creek (N = 45)	26.7	64.4	0.0	4.4	2.2	2.2
Both Counties (N = 148)	3.8	51.4	2.7	5.4	4.1	2.7

C. How many acres of Deep Fork River floodplain land do you own and/or lease? (circle ONE number that applies)

County	Surface Area Class (acres/hectares)				
	< 25 / < 10	25 - 50 / 10 - 20	51 - 100 / 21 - 41	101 - 320 / 41 - 130	> 320 / > 130
Lincoln (N = 103)	11.7	24.3	18.4	30.1	15.5
Creek (N = 42)	9.5	14.3	19.0	42.9	14.3
Both Counties (N = 148)	11.0	21.2	18.5	33.6	15.8

D. Presently, I (circle one or more of the numbers that apply)

Job Category	County		
	Lincoln (%) (N = 103)	Creek (%) (N = 43)	Both Counties (%) (N = 146)
Farm or Ranch Full-time	14.6	9.3	13.0

APPENDIX C. CONTINUED

Job Category	County		
	Lincoln (%) (N = 103)	Creek (%) (N = 43)	Both Counties (%) (N = 146)
Farm or Ranch Part-time	15.5	16.3	15.8
Other Occupation	29.1	30.2	29.5
Retired	24.3	23.3	24.0
Farm or Ranch Part-time + Other Occupation	8.7	9.3	8.9
Farm or Ranch Part-time + Retired	4.9	2.3	4.1
Other Occupation + Retired	1.0	0.0	0.7
Other	1.9	9.3	4.1

E. What is your current age? _____ years

County	Age Class					
	26 - 41 (%)	42 - 49 (%)	50 - 57 (%)	58 - 65 (%)	66 - 73 (%)	74 - 89 (%)
Lincoln (N = 105)	11.4	19.0	16.2	27.6	11.4	14.3
Creek (N = 44)	11.4	13.6	18.2	29.5	13.6	13.6
Both Counties (N = 149)	11.4	17.4	16.8	28.2	12.1	14.1

APPENDIX C. CONTINUED

E. Which one of the following categories best approximates your NET annual income from all sources including salary, dividends, royalties, etc.?

County	Income Category				
	less than $8,000 (%)	$8,000-$18,000 (%)	$18,001-$30,000 (%)	$30,001-$50,000 (%)	greater than $50,000 (%)
Lincoln (N = 99)	13.1	25.3	29.3	13.1	19.2
Creek (N = 39)	2.6	10.3	20.5	33.3	33.3
Both Counties (N = 138)	10.1	21.0	26.8	18.8	23.2

* Percentages may not add to 100 due to rounding errors.

APPENDIX D.

REMINDER POSTCARD FOR DEEP FORK RIVER, OKLAHOMA SURVEY.

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29 October 1984

Dear Deep Fork River landowner, lessee, and/or taxpayer,

In early October you received a letter and confidential questionnaire concerned with our study of Deep Fork flooding problems and potential solutions. In case you have set the questionnaire aside and have not yet returned it, I ask you to please complete it and mail it soon in the convenient postage paid envelope. Your input is very important.

If you already returned the questionnaire, please excuse this reminder. Thank you for your cooperation.

Sincerely,

Thomas J. Taylor
Research Leader

APPENDIX E.

RETURN AND USEABILITY [++] RATES OF DEEP FORK RIVER QUESTIONNAIRE SURVEY RESPONSES FOR LINCOLN AND CREEK COUNTIES, OKLAHOMA.

Survey Instrument	No. Sent		No. Returned		Return Rate (%)		Useable Returns		Useable Returns (%)	
	L	C	L	C	L	C	L	C	L	C
Pilot Survey	30	30	11	11	37	37	11	10	37	33
Primary Survey	209	108	105	42	50	39	96	35	46	32
Total	239	138	116	53	--	--	107	45	45	33

[++] Returns were considered useable if responses were complete, readable, and not mutually exclusive.

APPENDIX F.

STREAM RENOVATION FIELD ASSESSMENT KEY FOR EVALUATING THE DEEP FORK RIVER AND RIPARIAN COMMUNITY IN LINCOLN COUNTY, OKLAHOMA.

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(1) COMMUNITY TYPE
- BH = bottomland hardwood
- NG = native grass/vegetation
- C = cropland: wheat, sorghum, alfalfa, fallow, pecan, disced
- TG = tame grass
- A = aquatic (+ semi)
- E = eroded or bare
- B = brush--weedy, some shrubs or small trees
- O = orchard

(2) TIMBER CLASS
- T = tree: > 5
- S = shrub: 30cm - 5m
- H = herb: < 30cm - 1m

(3) DBH (@ 1.5 m)
- 1 = < 2 cm (seedling)
- 2 = 2 - 6 cm (sapling)
- 3 = 6 - 10 cm (pole)
- 4 = > 10 cm (saw)

(4) COVER/HABITAT CONDITION RATING

Class	Cover	Criteria
1	0-5%	very poor condition: numerous eroded sites, little veg. cover; deteriorating conditions
2	5-25%	generally poor condition: some erosion; scattered veg. cover overgrazed or Other Significant Disturbance (OSD); trend toward Class 1
3	25-50%	fair condition: generally good veg. cover; slight to moderate grazing or OSD; trend more or less constant
4	50-75%	good condition: only moderate grazing pressure or OSD; apparent good wildlife cover present, good diversity of habitat types; trend constant or improving to Class 5
5	75-100%	excellent condition: apparent climax; little or no grazing pressure or OSD; better cover and diversity than Class 4

(5) WILDLIFE SPECIES (Observations)
behavior, number, sex, age

(6) WILDLIFE SPECIES (Sign)
scat, feather, carcass, den, bone, tracks, pellet, nest, song

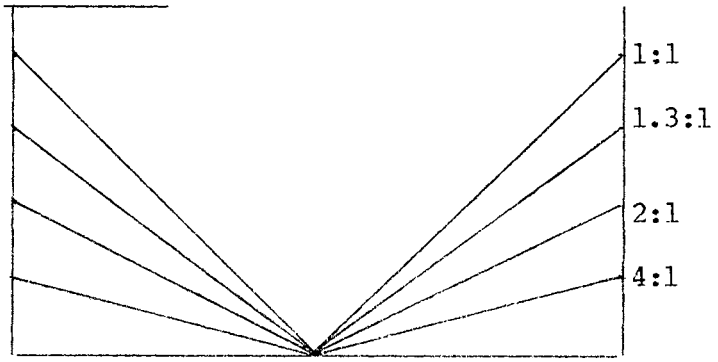
(7) FENCE CONDITION
- S = satisfactory; no repairs necessary
- U = repair/replacement necessary or N if nonexistent

APPENDIX F. CONTINUED

(8) DISTURBANCE

LS = livestock
L = levee
D = ditch
T = trail
TH = timber harvest
O = petroleum
OT = other
SD = sediment deposit
scour
failure: slump/slab

(9) BANK SLOPE



(10) BAR (BR) or BLOCKAGE (BL) REMOVAL

L = channel left
M = mid-channel
R = channel right

(11) SNAGGING

> 30 = from vertical
DT = den tree
TP = top/prune? (a main or smaller branch)
TR = total removal (i.e. leave stump)
RS = remove stump--on bank

(12) NECESSARY RENOVATION

Reveg = revegetation
Riprap
Armor = i.e. with logs (dia $\geq$ 20 cm)

VITA

Thomas J. Taylor

Candidate for the Degree of

Master of Science

Thesis: PLANNING TECHNIQUES FOR RENOVATION AND MANAGEMENT OF THE DEEP FORK RIVER, NORTHCENTRAL OKLAHOMA

Major Field: Wildlife Ecology

Biographical:

Personal Data: Born in Cedar Rapids, Iowa, April 10, 1954, to Richard L. and Dorothy E. Taylor; married to Deborah Moorman on August 18, 1979; parents of Joshua and Alex Taylor.

Education: Graduated from Regis High School, Cedar Rapids, Iowa, in May, 1972; attended the University of Iowa from September, 1972, through August, 1976; received a Bachelor of Science Degree in Fisheries and Wildlife Biology from Iowa State University in November, 1978; completed a 32 hour continuing education course, entitled Flood Plain Analysis: Open Channel Hydraulics, at the University of Oklahoma in September, 1984; completed requirements for the Master of Science Degree at Oklahoma State University in August, 1986.

Professional Experience: Nature Counselor, Boy Scouts of America camp, June through August, 1974; Counselor, Young Men's Christian Association youth camp, June through August, 1975; Wildlife Technician's Aide, Iowa Conservation Commission, June, 1976, and June through August, 1977; Conservation Aide II, Nebraska Game and Parks Commission, March, 1979, to October, 1980; Research Assistant, Department of Biochemistry, University of Iowa, November, 1980, to May, 1981; Teaching Assistant, Department of Zoology, Oklahoma State University, September, 1983, to May, 1984; Wildlife Biologist, U.S. Fish and Wildlife Service, June, 1985, to present.

Professional Affiliations: The Wildlife Society, National Wildlife Federation, National Audubon Society.

Honors: Oklahoma State University Center for Water Research