ADEQUACY OF FISH AND WILDLIFE PLANNING FOR HUGO LAKE IN SOUTHEASTERN OKLAHOMA

By

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PREFACE

The objective of this study was to evaluate planning for fish and wildlife at Hugo Lake in terms of: (1) interagency communication and cooperation, (2) biological importance and implementation of specific recommendations, (3) pre-impoundment and post-impoundment occurrences of fish and wildlife, (4) population and habitat improvement measures.

I wish to express my sincere appreciation to my major adviser, Dr. Michael D. Clady, for his patience and guidance. Special thanks are given to Dr. O. Eugene Maughan and Dr. Paul A. Vohs who served on the advisery committee. Thanks are also given to Dr. Terry McNeill for his friendship.

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CHAPTER I

INTRODUCTION

The magnitude of water development in the United States is enormous. Chorley and Kates (1) estimate that 10 percent of the national wealth of the United States has been committed to capital expenditures for structures designed to collect, divert, and store surface water, as well as distribute, cleanse, and return it to the natural system. The context of water development in the United States, however, has changed from that of an expanding nation which utilized such projects to encourage settlement of empty lands and provide employment, to one in which consideration must be given to providing a healthy, natural environment and abundant, varied recreation. The conflict between escalating economic development in the form of water projects and environmental considerations has become increasingly intense.

Planning for fish and wildlife in the case of artificial impoundments generally falls into two major categories, mitigation and enhancement. Mitigation involves efforts to minimize the natural consequences of impoundment on fish and wildlife resources. Enhancement efforts attempt to increase human utilization of these resources, and are, in a sense, production of an economic good, the fulfillment of human needs. Within the literature, these planning goals are often lumped together and referred to as "mitigation".

Planning for fish and wildlife, as well as planning for all the

other aspects of a multi-purpose reservoir, is complicated by the political background, the engineering aspects, the magnitude of biological resources, and the socioeconomic conflicts, as outlined in Water Policies For The Future, the 1973 Report of the National Water Commission. "Equal consideration and coordination of wildlife conservation with other water resources development programs" was the intent of the Fish and Wildlife Coordination Act as amended in 1958. This act provides that conservation agencies responsible for fish and wildlife resources be consulted regarding all project developments, and that the Federal planning agency respond specifically to their reports and recommendations for mitigation and enhancement (2). Evaluation of planning for fish and wildlife, therefore, involves inspection of interagency communication, including philosophy and procedures, as well as evaluation of the biological soundness and implementation of specific recommendations.

Agency responsibilities for fish and wildlife planning at Hugo Lake overlap. Resident fish and wildlife belong to the State of Oklahoma regardless of land ownership. The State, through the Oklahoma Department of Wildlife Conservation (ODWC), has the authority and responsibility to preserve, manage, and regulate all resident fish and wildlife. Both the U.S. Fish and Wildlife Service (FWS) and the ODWC are responsible for the management of all migratory animals. The U.S. Army Corps of Engineers (CE) has the responsibility to restore, improve, and maintain fish and wildlife on Corps of Engineer lands through appropriate practices and habitat development.

Section three of the Fish and Wildlife Coordination Act provides for the use of civil works projects for the management of fish and

wildlife and their habitat (3). Land and water areas under jurisdiction of the Department of the Army may be made available to state wildlife agencies for wildlife management by license agreement. There are approximately 7,369 hectares (ha) (18,196 acres) of perimeter lands and water areas at Hugo Lake available for licensing to the ODWC for fish and wildlife conservation and management purposes. For areas not managed through license or other cooperative agreement with wildlife agencies, the Corps of Engineers implement their own fish and wildlife management plan. Implementation of the plan is subject to the primary purpose for which the areas were zoned.

The purposes of this study were to document the effects on fish and wildlife resources of construction of Hugo Lake, to evaluate the coordination of agency responsibilities for fish and wildlife management, and to document efforts to ameliorate the adverse effects of development. The specific objectives were:

1. to discuss the suitability of present Corps of Engineer procedures, particularly benefit/cost estimates and man-hour recreational use estimates, to fish and wildlife mitigation problems;
2. to establish a record of interagency communication and cooperation in planning for fish and wildlife;
3. to determine the biological soundness of FWS recommendations;
4. to ascertain the effects of the project on fish and wildlife resources;
5. to determine which of the FWS recommendations on the project have been adopted and implemented;

6. to determine the degree of implementation and effectiveness of mitigation and enhancement measures recommended, installed, and operated by the Corps of Engineers and Oklahoma Department of Wildlife Conservation.

CHAPTER II

BACKGROUND

The U.S. Army Corps of Engineers and Environmental Concerns

The following major Congressional directives provide the framework for planning for all Federal water and related land resources development projects (4) (5). This legislation provides for full consideration of opportunities for recreation and fish and wildlife mitigation and enhancement in Federal projects:

A. Fish and Wildlife Coordination Act of 1958, 48 Stat. 401

B. The Federal Water Project Recreation Act of 1965, Public Law 89-72

C. The Water Resources Planning Act of 1965, Public Law 89-80

D. National Environmental Policy Act, Title I, 1 January 1970, Public Law 91-190

E. River and Harbor and Flood Act of 1970, 31 December 1970, Public Law 91-611

F. Federal Water Pollution Control Act Amendments of 1972, 18 November 1972, Public Law 92-500

G. Water Resources Development Act of 1974, 7 March 1974, Public Law 93-251

H. Principles and Standards for Planning Water and Related Land Resources, Water Resources Council, 10 September 1973, 38FR 24778-24869

Because planning for Hugo Lake occurred prior to impoundment in January, 1974, not all of the above legislation was applicable to the

project, although the Principles and Standards (H) contain guidelines for some retroactive application.

The Corps of Engineers is responsible for planning and implementation of multipurpose water and related land resource developments throughout the United States. These development projects serve such diverse purposes as flood control, hydroelectric power generation, irrigation, municipal and industrial water supply, navigation, recreation, and fish and wildlife. The Corps was been involved in water development projects since prior to 1824 (6). Legislative authority for construction of flood control structures was obtained in a general form in 1917 and more specifically by the provisions of the Flood Control Act in 1936 (7). It was not until the Fish and Wildlife Coordination Act of 1958, however, that the Corps received a legislative mandate to consider fish and wildlife resources in conjunction with water resource development projects. During the 1960's and 1970's Congress provided the Corps of Engineers with many more legislative directives concerning the environment.

The environmental mission of the Corps is to carry out the mandate of the National Environmental Policy Act of 1969 to:

> encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the nation; and to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generation of Americans (8).

In the era prior to the implementation of the Principles and

Standards, the Corps of Engineers did multipurpose planning for a variety of the functions of water resource development, but national economic development was the single objective. The Principles and Standards state that plans should be formulated to also meet Environmental Quality objectives which must "enhance the quality of the environment by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems" (9).

Economic Considerations in Planning

Water project evaluation by the Corps of Engineers applies some of the theorems of welfare economics to individual projects in a process known as benefit/cost analysis (10). The economic analysis of such projects is essentially concerned with the efficient use of resources. There has been, however, considerable debate over the extent of the applicability of benefit/cost analysis to natural resource development (11). There is a host of considerations other than economic efficiency which have been traditionally important to government in the United States. Some of these are recreation, fish and wildlife, income distribution, regional development impacts, and economic growth (12). In addition, some of the output from government projects, such as outdoor recreation, may have no specific market value. Benefit/cost analysis also allows the analyst considerable freedom to make assumptions, and consequently abuses are quite possible.

In addition to semi-intangible activities like recreation, there are fully intangible environmental concerns involved in the development of water projects. Shelton (13) has suggested a scheme for incorpo-

rating intangibles into economic analysis of water projects in order to reflect a broader spectrum of interests. Benefit/cost analysis in the past has usually reflected only easily measured monetary values.

Economic theory also has something to say about the value of unique resources such as fish and wildlife, especially those which utilize river and stream habitats. The demand durve for resources that have few or no substitutes is highly inelastic (14). The nature of an inelastic demand function implies that the price of a unique resource increases sharply as the quantity of the resource is reduced. The applicability of this theory to "quality of life" experiences, the human use of unique outdoor resources, is somewhat limited, however, in that it is impossible to derive an absolute monetary value for these experiences.

Wood (15) described an example. In 1968, the Corps of Engineers submitted a proposal for the construction of a multi-purpose dam and reservoir on the Eel River at Dos Rios, California. The Corps proposals attempted to provide for mitigation of adverse environmental effects to be created by the project. These proposals received considerable adverse public comment. These protests imply that the public placed a higher value on certain environmental quality parameters than did the Corps of Engineers. Wood further stated that Corps estimates for the cost of mitigation have been consistently low, but adds that the Corps has been willing to negotiate in respect to mitigation measures.

There is controversy over the monetary value of a man-day of recreation, and even whether such man-day estimates are applicable to

resource-loss mitigation planning. Prior to 15 May 1962, the Bureau of Sport Fisheries and Wildlife valued a fishery by the "sportsmen expenditure" method (16). After 1962, values for recreational fishing were based on provisions in Senate Document No. 97, Supplement No. 1, 87th Congress and were independent of actual fisherman expenditures. New guidelines, replacing Sen. Doc. 97, raising the maximum value/man-day for certain types of recreational fishing to $9.00 were instituted in October 1973 (Principles and Standards). Currently, planning for resource-loss mitigation has employed a quantitative estimate of the value to the resource of the fish and wildlife habitat to be affected by a water development project. Habitat evaluation procedures (17) were developed for use by the U.S. Fish and Wildlife Service, Division of Ecological Services, to provide a uniform nationwide method for determining impacts on fish and wildlife and their habitat arising from water development projects. The U.S. Army Corps of Engineers has also developed a tenative habitat evaluation system (18).

The California Department of Fish and Game (19) feels that the mitigation of losses is not an acceptable policy and that full resource preservation should be the objective. The Department is of the opinion that federal construction agencies have evaluated fish and wildlife losses in strictly monetary terms, such as from fishing and hunting use, disregarding the values of both game and non-game species which are not taken by sportsmen but preserve and maintain the diversity of the ecosystem. The function of wildlife losses assessed only in such monetary terms is to limit expenditures for preservation measures.

A report from the General Accounting Office (20) agrees with the California Department of Fish and Game analysis. The report states

that Bureau of Sport Fisheries and Wildlife (BSFW), now the U.S. Fish and Wildlife Service (FWS), officials did not presently use and objected to the use of man-day recreational use values to measure project losses. As their authority BSFW officials cited Senate Report 1981 (85th Congress), which recommended enacting amendments to the Wildlife Coordination Act of 1958. That report stated that wildlife and habitat loss prevention measures would not need to be justified by the usual benefit/cost analysis. BSFW officials felt that Corps of Engineers benefit/cost analysis based on benefits from man-days of recreation were inadequate since on-site hunting values represent only part of the environmental values affected. For example, land which was to be inundated by the Grand Teton project provided winter habitat for up to 90% of the deer in the Teton Basin. The BSFW contended, therefore, that construction of the project would essentially annihilate this herd, eliminating hunting opportunities not only in the project area but also in the entire Teton Basin as well.

Recent Efforts to Improve Fish and Wildlife Planning for Water Resource Development Projects

One of the first attempts to evaluate the effectiveness of wildlife mitigation measures was a report entitled Ex Post Evaluation of Fish and Wildlife Mitigation, a review of selected Bureau of Reclamation projects, prepared by Rivus, Inc in 1973 for the Bureau of Sport Fisheries and Wildlife. In March 1974, The General Accounting Office published a report entitled Improved Federal Efforts Needed to Equally Consider Wildlife Conservation with Other Features of Water Resource

Development (20). This report was compiled as a result of a request of the House Subcommittee on Fisheries and Wildlife Conservation and the Environment to review implementation of sections 2 and 3 of the Fish and Wildlife Coordination Act. The general conclusion of the report was that:

> Water resource development and wildlife agencies need to improve their efforts to equally consider wildlife conservation with other features of water resource developments. Generally, wildlife conservation has not been considered equally with other features of the 28 water resource developments considered (p. 11).

Breakdowns in the coordination process involved:

1) development agencies not always consulting with wildlife agencies
2) wildlife agencies did not adequately evaluate wildlife effects on proposed developments
3) wildlife agency study reports were not provided prior to project approval or authorization and recommendations for wildlife conservation were too general
4) on some SCS watershed projects, wildlife mitigation measures were not recommended
5) wildlife agencies did not follow up to determine whether wildlife measures were being implementd (p. 38)

Additional problems identified were the need to clarify the roles of the wildlife agencies (coordination among wildlife agencies), and the inadequate funding and staffing of wildlife agencies.

In April 1975 the Sport Fishing Institute, under contract to the Corps of Engineers, launched a Study to Evaluate the Adequacy and Predictive Value of Fish and Wildlife Planning Recommendations at Corps of Engineer Reservoir Projects. This study is in progress and involves compilation and comparison of pre- and post-construction data treating fish, wildlife, or both fish and wildlife (depending upon data availablility) for twenty separate CE water development projects. A final report is schedule at the completion of the twenty separate studies.

Recommendations for improving the planning process will be included.

By December 1976 two firms under contract to the U.S. Fish and Wildlife Service, Jones and Stokes, Inc., of Sacramento, California and Enviro Control, Inc., of Rockville, Maryland, had completed a seven-part series entitled Assessment of Effects on Altered Stream Flow Characteristics on Fish and Wildlife. Objectives of these studies were to determine the actual effects of altered flows on fish and wildlife downstream from dams and diversions, as well as to evaluate methodologies for predicting these effects.

Currently Enviro Control, Inc., is under contract to the Western Energy and Land Use Team of the FWS to document successful and potentially successful habitat and population improvement measures accompanying water resource development projects (22). These measures include both structural and operational features as well as direct habitat modification and population control. The research findings are to be incorporated into a handbook which will present engineering features, hydrological and biological effects, and relative costs.

Ecological Impacts of Impoundments on Fish and Wildlife

The impoundment of water results in ecological impacts are many and varied. Thermal stratification in reservoirs is discussed by Kittrel (23) and by Symons et.al. (24). The temperature change most noticeable in the impoundment is the warming of the surface layer, which encourages recreational use, but at the same time alters aquatic life. Siltation of reservoirs may also be a problem, especially in midwestern states such as Oklahoma. Silt that would remain suspended in moving

water is deposited within the impoundment. Jackson (25) maintained that the effects of silt are nearly always adverse; deposits may smother vegetation and inhibit its growth, smother fish eggs, prevent construction of nests on hard substrates, and fill up certain areas of a reservoir.

The species composition and habitat components of an impoundment are vastly different from those of the original stream. Little (26) discusses the invasion of man-made lakes by plants, which can dramatically impede recreational use of a reservoir. In some reservoirs with greatly fluctuating water levels, vegetation is killed along the edges by a high water level, and a barren area is exposed when the level is lowered (27). These fluctuations, however, may be helpful in controlling nuisance aquatic plants.

Fish and benthos are also affected by creation of an impoundment. Over a period of years with greatly fluctuating water levels, reproduction of largemouth bass and bluegill (See Appendix B for scientific names) may not be sufficient to sustain a viable population. Water level fluctuations were reported to be responsible for poor reproductive success of northern pike (Esox lucius), Sauger (Stizostedion canadense), and four other species of fish in some Missouri mainstream reservoirs (28). Changes associated with the aging of a reservoir increase numbers of rough fish and decrease the numbers of game fish (29). Conversely, water level fluctuations may also have beneficial effects on fish populations. The first few years of impoundment produce a "boom" in game fish populations. Water level fluctuations also greatly affect the littoral benthos (30).

Hagen and Roberts (31) summarize ways in which wildlife production

is altered by creation of an impoundment:

1) feeding areas are submerged
2) different types of areas are created
3) wildlife is usually more intensely managed in the vicinity of an impoundment
4) nesting and feeding areas for migrating birds are provided
5) a denuded zone is created by exposure during drawdown, restricting access to water by timid animals
6) 'people pressures' are created which may upset ecological balances, adversely affecting rare species (p. 136)

Ecological impacts downstream from the reservoir are also abundant. Symons, et al. (24) reported an abrupt change in water temperature from 24 C to 7 C when large discharges were made from the lower depths of a reservoir. Such releases can place great stress on aquatic life, adversely affect recreational use, and cause damage to irrigated crops. Periodic flooding of the river will no longer occur to flush out accumulated sediments and renew gravel-bed spawning grounds (19). Reservoirs also cause turbid water to flow in the river below over a longer period of time than under natural conditions. This condition can adversely affect fish and fisheries.

Dams create a barrier to anadromous fish and to fish that move upstream to spawn in feeder creeks. On the other hand, fish tend to congregate beneath dams at certain seasons of the year when releases are occurring. This phenomenon produces a "tail-race" or stilling basin fishery of great economic importance (32). In some cases, dams improve water quality of a stream.

Wright (33) listed six deleterious effects that dams with deep-water penstocks appeared to have on receiving streams. They were as follows:

1) water is released with a higher salinity than would be obtained from surface water withdrawal

2) essential nutrients are lost from the reservoir, thus tending to deplete the productive capacity of the reservoir, and at the same time causing eutrophication downstream
3) evaporative loss is increased as a result of storing warm epilimnal water
4) water too cold for satisfactory fish growth may be released
5) water with dissolved oxygen concentrations to low to handle downstream BOD may be released
6) in extreme cases, discharging hydrogen sulfide-laden water results in fish kills downstream (p. 270)

Impoundments alter the economic, social, and political life of an area. These alterations result in secondary ecological impacts. Some ecological impacts result from recreational and urban developments which often arise following reservoir construction. New reservoirs draw land developers who recognize the growing attractiveness of water and water-related activities, especially in semi-arid and hot climates. Aggressive developers have bought land areas surrounding proposed reservoirs often years in advance of construction. Water agencies or other public agencies, therefore, are unable to acquire sufficient land to provide adequate setback from the shoreline of the reservoir when developed.

Additional Aspects of Recreational Use

Eipper (34) stresses the complexity of planning for the multiple use of water resources. Processes in the human ecosystem have kept the size, complexity, and occurrence of resource use conflicts accelerating. The exponential rate of population increase contributes to the problem of resource use conflicts. Stroud (35) states that the problems of recreational use of impoundments generally fall within the following categories: (1) inadequate access to permit full use of fish and

wildlife resources; (2) conflicts arising over competing recreational use of the water surface and adjoining lands; (3) inadequate knowledge of ecology needed to provide for improved management of populations to sustain or restore good hunting and sport fishing.

The increasing demand curve for fishing shows no signs of abating. The Outdoor Recreation Resources Review Commission predicted that the amount of fishing in the year 2000 will be three times what it was in 1960 (36). The commission determined that over 3.25 million hectares of public waters in the United States were closed to fishing because of poor or non-existent access.

The extent of conflict between recreational uses was documented by Houser and Heard (37) on Oklahoma's 7,700 hectare Fort Gibson Reservoir. Speed-boat racing and water skiing produced such a disturbance that angling was severely reduced.

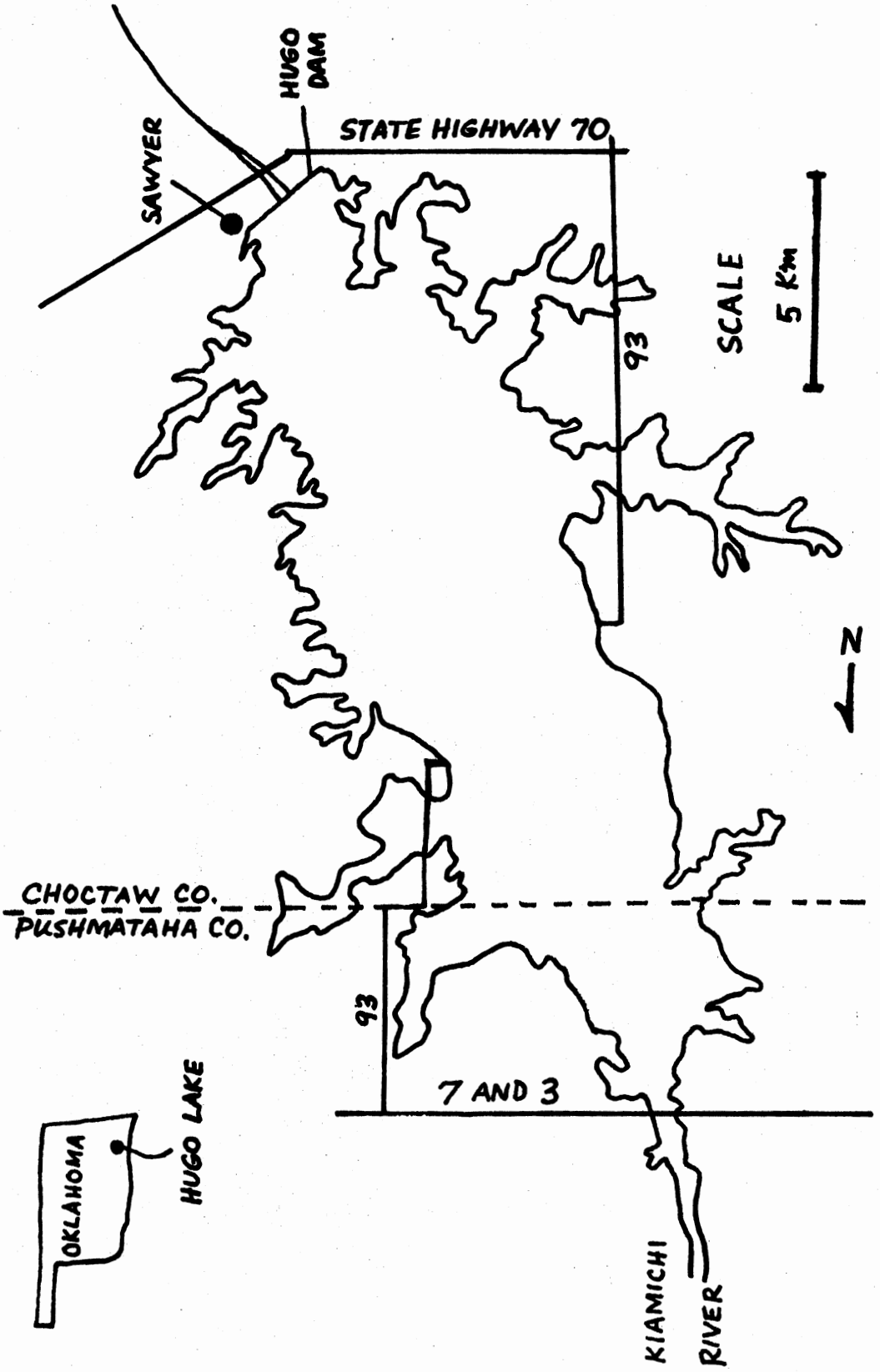
CHAPTER III

DESCRIPTION OF THE STUDY AREA

Hugo Lake is an impoundment created by the Army Corps of Engineers and located on the Kiamichi River (Figure 1). The damsite lies approximately 11 kilometers (km) east of Hugo in Choctaw County and about 29 km upstream from the confluence of the Kiamichi and Red Rivers. The project was authorized by the Flood Control Act of 1946, Public Law 526 and impoundment of the lake began in January, 1974. Construction was modified by Public Law 87-874 to a multipurpose project including flood control, water supply, fish and wildlife and recreation. Storage for water quality control was added as a project purpose within the Kiamichi River basin, consisting of Hugo, Clayton, and Tuskahoma Lakes. Clayton Lake is currently under construction; Tuskahoma has been authorized.

The structure of the dam, having a total crest length of 3,111 meters (m) and a maximum height of 30.8 m above the original stream bed, consists of an earthfill enbankment with a concrete, gravity-type spillway. The normal pool at elevation 123.4 m (404.5 feet) above mean sea level for initial operation of the project (without the other two lakes) has a capacity of 0.94 cubic kilometers (km^3) (157,300 acre-feet) for conservation and sediment reserve, and a surface area of 5,366 ha (13,250 acres). Storage for flood control provides a capacity of 0.999 km^3 (809,200 acre-feet) of water. The drainage area

Figure 1. Location of Hugo Lake


HUGO DAM
SAWYER
STATE HIGHWAY 70
93
SCALE
5 Km
N
CHOCTAW CO.
PUSHMATAHA CO.
93
7 AND 3
HUGO LAKE
OKLAHOMA
KIAMICHI
RIVER

of the lake is 4,426 X 10^3 km^3 (1,709 square miles). At the top of the flood control pool, elevation 133.4 m (437.5 feet), the lake has a surface area of 13,969 ha (34,490 acres). Storage allocations will be altered when Clayton and Tuskahoma Lakes become operative.

Six public use areas totalling 1,888 ha (4,662 acres) have been developed. Facilities provided include boat launching ramps, water wells, rest stations, fireplaces, picnic tables, and camping areas. In addition, the Hugo Game Management Area is 7,369 ha (18,196 acres), consisting primarily of river bottomland with limited areas of upland. The area is expected to be licensed to the ODWC by the Corps of Engineers. The Game Management Area consists of the Hugo Public Hunting Area and the Hugo Migratory Bird Refuge. The Public Hunting Area consists of 5,547 ha (13,696 acres), and the Migratory Bird Refuge is a 1,823 ha (4,500 acre) adjoining area.

Average annual precipitation on the watershed is approximately 122 cm (48 in.), with the greatest amounts of rainfall occurring during spring and early summer. The Kiamichi River basin lies in a region characterized by mild winters and comparatively long summers with high temperatures. The mean average temperature for the basin is 7 C.

The alluvial soil of the bottomland is the Atkins-Pope association. Atkins soils are gray clay loams of level, poorly drained bottoms. Pope soils are well-drained, somewhat browner loam. The poorly drained soils are utilized as pasture and hay crops. The well-drained soils are often used for oats and corn. The flood plain alluvium in the area averages 9 m in thickness, and consists of silts, clays, and sand. Residual soil covering is thin on the hilly slopes and abutments.

The Kiamichi is a meandering stream, deeply entrenched in the floodplain, and displaying exposed bedrock in the streambed. Above the reservoir the river possesses an average gradient of about 0.28 meters per kilometer (1.5 feet per mile). Below the damsite, the stream enters the alluvial plain of the Red River where the average gradient is about 0.15 meters per kilometer (0.8 feet per mile). Prior to impoundment, river flow fluctuated from over-flowing during the periods of heavy percipitation to absence of flow during drought.

Vegetation in the river drainage consists primarily of the shortleaf pine-hardwood type. Within the bottomlands of the project area, hickories, oaks, walnuts, elms, sycamores, willows, beeches, sweetgums, and scrub oaks as well as shrub species such as plum, redbud, dogwood, and sassafras grow. Native grasses are found in scattered tracts throughout most of the project area.

The principal industries in the project area are farming, cattle raising, lumbering, and some manufacturing. Farms are devoted to general agriculture with an increasing trend toward consolidation and subsequent livestock production. Manufacturing plants are generally related to forest resources.

CHAPTER IV

METHODS AND MATERIALS

The suitability of benefit/cost estimates and man-hours recreational use estimates to fish and wildlife mitigation problems was evaluated through a review of the literature. Reports, documents, and correspondence pertaining to pre-impoundment fish and wildlife impact assessments were reviewed at several locations. Hugo Lake project files were searched at the Environmental Resources Branch Office of the CE Tulsa District in Tulsa, Oklahoma. Project files maintained by the Ecological Services branch of the U.S. Fish and Wildlife Service were reviewed in Tulsa. Additional pre-impoundment fish and wildlife data were obtained through offices of the Oklahoma Department of Wildlife Conservation in both Oklahoma City and Durant, Oklahoma. Various post-impoundment reports on fish and wildlife resources were obtained at the same locations. Operations records were obtained at the CE Offices at the Hugo Lake damsite hear Hugo, Oklahoma. Additional information was gathered during interviews with state and federal personnel when the project was visited, and during telephone conservations.

Evaluations of planning input were partially accomplished through further interviews with agency personnel. Discussion of project effects on fish and wildlife is presented in a format similar to that utilized by the Sport Fishing Institute (38). This format utilized a comparison of pre-impoundment occurrences and predictions with post-

impoundment occurrences. An evaluation of planning input was then made based on these comparisons and knowledge of the planning history. Interviews were conducted and data collected at the Tishomingo and Sequoyah National Wildlife Refuges in order to ascertain the extent and success of habitat and population enhancement measures, especially those pertaining to waterfowl. These data were compared with observations and data on the program being conducted at the Hugo Game Management Area and Migratory Bird Refuge by the ODWC.

Nine specific recommendations made by the FWS for wildlife mitigation and conservation at Hugo Lake were examined in terms of their biological soundness, degree of implementation, and degree of success. Additional wildlife conservation measures implemented on project area lands were noted and where possible, evaluated in terms of probable success.

Comparisons were made between pre-impoundment predictions of man-hour recreational use and actual occurrences after impoundment. The original FWS projections were made based upon a 100-year period of analysis and considered hunting and fishing demands anticipated for the area based on the population that will reside within a day-use distance from the project site. Actual post-impoundment hunting and fishing use estimates were based on creel and bag censuses performed by the ODWC, and CE vehicular counts, adjusted for a load factor per car and an estimated percentage of persons anticipating in various recreational activities. Whenever qualitative or quantitative data were available concerning either animal populations or habitat conditions these were recorded in the appropriate pre-impoundment sections, either fish or wildlife.

Comparison of species diversity of fishes between the populations inhabiting the Kiamichi River in the project area prior to impoundment and populations inhabiting the lake after impoundment were made. Species diversity was calculated utilizing the Shannon index. Diversity (d) was calculated as $d=-\sum_{i=1}^{s} (P_i \log_e P_i)$, where $\underline{s}$ is the number of species in each category.

The chronology of events documenting interagency coordination and communication was constructed from agency records (Appendix A). The effects of planning are described in the "Evaluation of Planning Input" sections of "Fishery Resources" and "Wildlife Resources", respectively.

CHAPTER V

RESULTS AND DISCUSSION

On 12 February 1958, the FWS issued a narrative statement on the quality of the fish and wildlife resources of the Kiamichi watershed. The FWS's first Hugo Lake planning report was released on 6 June 1960 (39). On 11 January 1961, the CE provided the FWS with corrected engineering data regarding plans for flood control storage, and requested supplemental comment or report on revisions in the estimates of the reservoir's impact on fish and wildlife resources (40). The FWS responded to these changes on 22 March 1961 in a supplement to the earlier report (41). The FWS released the Fish and Wildlife Coordination Act Report (42), to be included as part of the Corps of Engineers' Design Memorandum, on 29 May 1968. The FWS report included both qualitative predictions of post-impoundment changes in fish and wildlife populations and habitats as well as quantitative projections of hunting and fishing use.

The CE published the Final Environmental Impact Statement (EIS) for Hugo Lake in February 1974 (43). In September 1976, the CE published their Fish and Wildlife Plan for Hugo Lake, Appendix D to Design Memorandum No. 3B, Public Use Plan (3).

Subsequent to the 1968 report, the FWS and ODWC were involved in frequent and lengthy communications and discussions concerning the management of wildlife on perimeter lands of the project area. One

area of controversy was partially resolved in May 1975, when the FWS began procedures to forego administration of the proposed Kiamichi National Wildlife Refuge in favor of ODWC administration of the area (44). However, the FWS, having responsibility for migratory waterfowl, has remained actively involved in formulation of the General Plan and license agreements.

Fishery Resources--Pre-impoundment

Fishery resources associated with the Hugo Lake Project prior to impoundment were described in the 1968 FWS report as follows:

> The quality of the fish habitat in the Kiamichi River ranges from moderate to excellent depending on water conditions. During the spring and early summer months, fishing success is highest, with channel catfish, crappie, largemouth bass, and various smaller sunfishes being taken along most reaches of the river. During periods of extended drought, fishing is limited to the deeper pools and success declines correspondingly.
>
> Public access to the Kiamichi River in the project area is and would continue (without the project) to be restricted to areas where roads cross or approach the river (p. 5).

No creel census data for the Kiamichi River were compiled prior to 1974, the year of impoundment. The 1968 FWS Report, however, made the following estimates of fisherman use:

> It is estimated that without the project, about 8,700 sport fisherman-days annually would be spent on the Kiamichi River within the reservoir area and 600 fisherman-days on the tributary streams within the reservoir area. During the same period, the 17.6-mile (28.3 km) reach of the Kiamichi River from the proposed damsite to its confluence with the Red River would sustain an estimated 5,300 sport fisherman-days per year. Thus, the total amount of stream fishing provided in the area of project influence would amount to approximately 14,600 man-days annually (p. 5).

The Environmental Impact Statement for Hugo Lake listed 85 species of fish which inhabitated the Kiamichi River and tributary streams

(Appendix B). A total of 12 species was considered abundant throughout the Kiamichi River Basin in 1972: spotted gar, stoneroller, bigeye shiner, ribbon shiner, Kiamichi shiner, redfin shiner, mimic shiner, brook silversides, green sunfish, bluegill sunfish, longear sunfish, and the orangethroat darter.

The EIS for Hugo Lake classified fishes of the Kiamichi River into functional categories of sport fish, pan fish, coarse fish, and forage fish. Sport fish is the group most sought by anglers, and these species are designated as game fish by the State of Oklahoma: black basses, crappies, channel catfish, and white bass. Pan fish are comprised of sunfishes, bullheads, and pickerel. The coarse fish category is represented by nongame and commerical fishes such as buffalo, carp, carpsucker, drum, redhorse, and gizzard shad. The remaining fishes, including minnows, darters, and other species with small adult forms were classified as forage fish.

The EIS shows absolute and relative abundance of fish that were collected in a survey conducted by the Oklahoma Biological Survey in 1972. Three sport fish, 85 pan fish and three coarse fish were collected in the lower segment of the Kiamichi River (encompassing the project site). These categories represent 0.1%, 1.8% (erroneously listed in the EIS as 0.1%), and 0.1% of the collected fish respectively. Also in the lower segment of the river, forage fish constituted 98.1% (erroneously listed in the EIS as 98.8%) of the collected fish. A total of 4,701 forage fish was collected. High population densities of the mimic shiner and the ribbon shiner were observed in the lower Kiamichi River prior to impoundment. Collectively, the mimic and ribbon shiner constituted 66% of the total forage fish in the lower

Kiamichi River. The Kiamichi shiner was extremely rare (only 0.2%) in the lower portion of the river.

Species diversity values were calculated for each functional group of fish using the Shannon index (Table 1). Although the ribbon and mimic shiners constituted the greater portion of fishes in the lower portion of the river, 22 species were collected there.

The EIS for Hugo Lake predicted that the relative abundance of fish species would undergo changes subsequent to impoundment, stream fishes being replaced by those species which prefer deep, soft-bottomed pools. The following prediction concerning sport fish were made:

> Although the black basses are not presently abundant within the Kiamichi River, their ability to abound in lake-like conditions will result in a significant increase in both their relative and absolute abundance. This change will involve primarily the largemouth bass, and the spotted bass, with the largemouth becoming the dominant species in the lake. Although the largemouth will inhabit the head-waters, the spotted bass will likely become the dominant species in ecotonal areas. It is probable that both species will decline within the tail-waters of Hugo Lake.
>
> Abundance of both black crappie and the white crappie will increase significantly within the lake. The white crappie likely will become dominant.
>
> Within the lake, the channel catfish will become a significant fishery. This condition may be come somewhat reduced after a period of ten years, although the standing crop of channel catfish will undoubtedly remain higher than during pre-impoundment conditions (p. 3-29).

It was expected that gizzard shad would become the dominant species in Hugo Lake, and that the gars would also be abundant.

The EIS also predicted:

> Species of coarse fish are likely to increase significantly within all areas, but especially within the reservoir and the downstream area. Species diversity of this group will undoubtedly increase, with the gizzard shad and carpsucker obtaining dominance. Relative and absolute abundance of forage species to remain high, as influenced by threadfin

Table 1. Species diversity[a] for categories of fishes in the lower stream segment of the Kiamichi River in 1972 (from Oklahoma Biological Survey, (45)).

Category	Number of Individuals	Species Diversity
Sport	3	1.01
Pan	85	1.12
Coarse	3	0.55
Forage	4701	1.81

[a] see text, page 24, for formula

> shad and brook silversides. Diversity for this group is expected to decline, for certain riverine species of minnows and darters will likely be reduced or replaced in both the lake and its tailwaters. Some, however, are expected to increase or maintain populations, e.g., the golden shiner, the bigeye shiner, bluntnose minnow, blackband topminnow, mosquitofish, and the logperch (p. 3-32).

Predictions about the general nature and species composition of Hugo Lake were made in the 1968 FWS report:

> At average annual minimum pool elevation, Hugo Reservoir will be an 8,500-acre (3,443 ha) impoundment. It will be a relatively clear, fertile body of water capable of initially supporting good populations of such sport-fish species as largemouth bass, white crappie, channel catfish, bluegill, and various smaller sunfishes. Past experience, however, indicates that long-range environmental conditions will prove more favorable for the production of nongame but commercially valuable fishes. Such species as freshwater drum, carp, white bass, buffalofish, gar, and carpsucker will predominate in later years and, as these species become dominant, sport fishing will decline (p. 6).

The 1968 FWS Report mentioned the large amount of impounded water in the immediate vicinity of Hugo Reservoir (121,500 ha of available reservoir fishing water with a 121 km radius by the year 2024) but still maintained that the reservoir would attract anglers from thoughout southeastern Oklahoma and Northeastern Texas. It was projected that Hugo Reservoir would produce 68,000 sport fisherman-days annually within the reservoir proper, and an additional 10,000 sport fisherman-days annually in the stilling basin (Table 2). The relatively high estimate of stilling basin use was partially based on the creation of good sport fishing produced by more uniform flows than normally would occur under pre-impoundment low flow conditions. A commerical catch of 58,200 kg of fish within the reservoir and 2,730 kg in the downstream segment of the Kiamichi River was projected.

Five specific recommendations concerning fishery resources were

Table 2. Summary of project effects on fishing (partially from (42)).

Item	Unit	Without Project	With Project	Gain or Loss
Sport Fishing				
Kiamichi River Within Hugo Reservoir	Man-day	8,700	0	-8,700
Kiamichi River downstream from reservoir	Man-day	5,300	6,800	1,500
Tributary Streams	Man-day	600	0	-600
Hugo Reservoir	Man-day	0	68,000	68,000
Hugo Reservoir	Man-day	0	10,000	10,000
Commerical Fishing				
Kiamichi River downstream from Hugo Reservoir	kg	2,730	2,730	0
Hugo Reservoir	kg	0	58,200	58,200

made by the FWS (42):

1. Two properly cleared and charted seining areas totaling about 970 acres (393 ha) be provided in Hugo Reservoir at an estimated project cost of $30,000.

2. All-weather fishing walkways and berms with guardrails be provided in the stilling basin area or near the retaining wall of the Hugo Dam to help assure fisherman safety and to facilitate additional fishing in the stilling basin area. Costs for the facility would be insignificant if incorporated into the initial design of the dam.

3. A minimum instantaneous flow of 20 second-feet (5.66 m^3 per second) be maintained in the Kiamichi River during the months of December and January.

4. A boat-launching ramp be provided as part of the proposed access area downstream from the dam at an estimated project cost of $4,000.

5. Existing timber and brush be left standing in the reservoir basin above elevation 390.0 feet (119 m) as well as on the project lands wherever it would not conflict or interfere with project operation (p. 15).

The CE's Fish and Wildlife Management Plan (3) included the following recommendations to improve and maintain quality fishing:

1. Encourage the State to introduce threadfin shad, Mississippi silversides, walleye, Florida bass, and bybrid sunfish to supplement the total fisheries.

2. Work with the State in developing a water level stabilization plan during April-June to enhance spawning activities.

3. Prepare a map showing shallow flats, tributary channels, boating lanes and lake contours.

4. Construct a boat ramp for the downstream fishery.

5. Determine the feasibility of maintaining releases of water during the summer months to the tailrace of 50 second-feet (14.15 m^3 per second) to attract and sustain fish in the stilling basin and down stream areas (p. 2-5).

Fishery Resources--Post-impoundment

Prior to final impoundment, which began in January 1974, the ODWC initiated a stocking program at Hugo Lake (Appendix C). A total of 670,927 fingerling channel catfish was stocked in the partially filled reservoir between April and November 1973. Stocking of largemouth bass was initiated with the release of 250,315 advanced fry in May 1973. In May 1974 an additional 412,500 advanced largemouth bass fry and 10,000 Florida largemouth bass fry were stocked. Walleye (Stizostedion vitreum) and threadfin shad were stocked in April of 1974 and additional walleyes were stocked in April 1975. In July 1975, 30,000 hybrid largemouth bass were stocked. A total of 45,000 Florida largemouth bass was stocked in May 1976 and June 1977. Walleye were again stocked in March 1977. The last stocking to date has been that of 5,500 blue catfish in October 1977.

Section 2-01 of the Corps of Engineers' Fish and Wildlife Management Plan (3) describes the Hugo Lake fishery as follows:

> Hugo Lake was impounded in 1974 and has a surface area of 13,250 acres (5,355 ha) at the conservation pool level, elevation 404.5 (123.4 m). This expanse of water contains a diverse fishery population containing approximately 85 fish species. Sport fish commonly caught include black basses, crappie, channel catfish, and white bass. Other species are sunfishes, bullheads, pickerel, buffalo carp, carpsuckers, drum, redhorse, gizzard shad, minnows, and darters. The variety of fishery available to the public will contribute significantly to the recreational potential of Hugo Lake (p. 2-1).

Fish populations were surveyed by the ODWC between 5 May and 29 November 1977. The ODWC reported its findings in a Job Progress Report for Dingell-Johnson (D-J) Project F-15-R-14 (46). A summary of the results of this survey is listed in Table 3. Survey methods included

Table 3. Number, Total Weight, Relative Abundance by Number and Weight, and Mean Weight of Fish Collected by all Gears in Hugo Reservoir, 1977 (46)

Species	Number	Weight (g)	Percent Number	Percent Weight	X Weight (g)
Unknown	2	23.0	.08	.01	
Largemouth bass	68	9932.0	2.72	3.36	146.06
White crappie	387	44305.2	15.48	14.98	146.48
Black crappie	2	322.0	.08	.1089	161.00
White bass	138	8449.0	5.52	2.86	61.22
Channel catfish	40	37910.5	1.60	12.82	947.75
Bluegill	257	3082.0	10.28	1.04	11.99
Longear sunfish	103	2430.0	4.12	.82	23.59
Orangespotted sunfish	2	27.0	.08	.01	13.50
Redear	2	120.0	.08	.04	60.00
Green sunfish	14	414.0	.56	.14	29.57
Warmouth	12	434.0	.48	.14	36.17
Carp	36	80367.4	1.44	27.17	2232.43
Freshwater drum	7	4597.0	.28	1.55	656.71
Smallmouth buffalo	21	60217.8	.84	20.36	2867.51
Bigmouth buffalo	1	3572.1	.04	1.21	3572.1
River carpsucker	1	680.4	.04	.23	680.4
Yellow bullhead	1	370.0	.04	.13	370.0
Black bullhead	128	1385.0	5.12	.47	10.82
Goldenredhorse	3	2097.9	.12	.71	699.30
Shortnose gar	2	-	.08	-	-
Bowfin	2	2621.2	.08	.89	1310.60
Gizzard shad	560	32006.0	22.40	10.82	57.15
Mississippi silversides	412	386.0	16.48	.13	.94
Mosquitofish	22	-	.88	-	-
Emerald shiner	1	1.0	.04	.00	1.00
Blacktail shiner	275	30.0	11.00	.01	.11

electrofishing, shoreline seining, and gillnetting.

In this survey 26 species were captured, including four species of game fish - largemouth bass, crappie, white bass, and channel catfish. These species constituted 34.13% by weight of fish collected by all gear types in the survey. Rough fish constituted 8.08% of the numbers and 52.72% of the total weight, and forage fishes accounted for 50.8% of the total numbers and 11.0% of the total weight. No threadfin shad were collected during the survey. Water temperatures have been less than 4 C during the winters of 1976-1977 and 1977-1987 so that threadfin shad populations may have been completely wiped out by cold water temperatures. The three dominant non-game fish collected-carp, smallmouth buffalo, and gizzard shad - constituted 58.35% of the weight of the sample.

Successful recruitment of largemouth bass occurred during 1976 and 1977, but growth rate of this species was slightly below the state average rate (Table 4). Growth rate of crappie was similar to the state average. Channel catfish grew at an above-average rate. Condition of crappie and channel catfish was similar to state averages. White bass were in above-average condition.

Species diversity indices calculated from raw data in the ODWC report are listed in Table 5. The fish have been separated into functional categories, utilizing the same categories and criteria for placing a species in a particular category as were used in the EIS for Hugo Lake. Species diversity values for sport fish, panfish, coarse fish, and forage fish were 1.06, 1.25, 0.52, and 0.80, respectively.

A creel survey was conducted at Hugo Lake between 1 July 1974 and 30 June 1975 by the ODWC as part of an effort to interview fishermen on

Table 4. Mean back calculated length in millimeters at each annulus formation for largemouth bass collected from Hugo Reservoir in 1977 (46)

Year Class	Age Group	No. of Fish	Average Calculated Total Length at End of Year					
			1	2	3	4	5	6
1977	0							
1976	I	9	118					
1975	II	12	126	204				
1974	III	11	125	200	254			
1973	IV	3	136	199	259	312		
1972	V	2	145	208	296	339	377	
1971	VI	1	116	212	271	307	372	402
Weighted Average			125	203	261	320	375	402
Average Statewide			128	209	279	338	393	444

Table 5. Species diversity[a] for categories of fishes in Hugo Lake in 1977

Category	Number of Individuals	Species Diversity
Sport	635	1.06
Pan	519	1.25
Coarse	633	0.52
Forage	710	0.80

[a] see text, page 24, for formula

all Oklahoma reservoirs over 203 ha in surface area (48). The data are summarized in Appendix D. Over the course of this one year, fishermen angled an estimated 29,174 man-days. Average catch rate was 1.77 fish, weighing 0.51 kilogram (kg), per hour for all species. In the stilling basin, an estimated 22,007 man-days of fisherman use occurred. These fishermen, on the average, caught 1.37 fish/hour, weighing 0.29 kg.

Angler use estimates were also developed by the CE. Their figures were derived from a system of traffic counters established at entrances to various access points. In 1977 the CE reported 832,100 user-days for the Hugo Lake project (48). The proportion of this activity composed of fishing, based on monthly estimates, was approximately 31%. Thus, the CE estimate of angling use of Hugo Lake in 1977 was 258,400 angler-days. This was approximately 5.2 times greater than the ODWC estimates for the year from July 1974 to June 1975.

The ODWC creel survey showed that, within the reservoir, crappie were the most commonly caught species, both numerically and in terms of weight, followed by largemouth bass, white bass, and channel catfish, in that order. Respective average weights of the four species were 0.20, 0.39, 0.50, and 0.24 kg/fish caught.

In the stilling basin, the area directly below the dam, crappie were also the most frequently-caught species followed by channel catfish, drum, and white bass. Respective average weights were 0.13, 0.30, 0.47, and 0.16 kg/fish.

Relatively extreme fluctuations in water level have occurred on Hugo Lake since impoundment (Appendix E). In 1974 lake levels reached extreme highs in June (127.5 m above mean sea level (msl), 4 m above

the top of the conservation pool) and November (129.1 m above msl, 5.8 m above the top of the conservation pool). In each case levels had returned to the conservation pool level of 123.4 m within 18 days. In 1975 fluctuations were not as severe with moderate peaks in February (126.4 m), April (125.4 m), and June (124.8 m). In 1976 lake level reached a peak of 126.5 m in April with only minor fluctuations throughout the remainder of the year. In 1977 the lake rose to 129.2 m above msl during the last few days of March. Consistently low levels occurred after the month of May. Average annual minimum pool since impoundment has been at 122.7 m above msl. Fishermen at Hugo Lake often attribute poor fishing success to these fluctuations. However, length frequency data indicate that most gamefish successfully reproduced in both 1976 and 1977.

Extremely high flows below the dam at Hugo Lake occur periodically following periods of heavy rain, when releases are made to lower lake level to the top of the conservation pool (See Appendix F). On five occasions in 1974 flows exceeded 515 cubic meters (m^3) per second (18,200 cubic feet per second).

In the last week of March 1977, rains which raised the lake level to 129.2 m above msl caused flood waters in the Red River to back-up into the lower Kiamichi River. All gates were closed from the afternoon of the 27th to the morning of the 30th. Tailwater height rose to 114.4 m above mean sea level by 28 March and had reached 116.5 m above msl by 4 April and 116.8 m above msl by 7 April. The parking lot for the stilling basin area (approximately 116 m above msl) remained inundated by the floodwaters for about one week. Tailwater height remained consistently above 113 m until 25 April.

Construction of all public use areas was completed by January 1977 (personal communication, James Holder, CE, Hugo, 1978). Completion of boat ramps had been accomplished in 1973.

Fishery Resources--Evaluation of Planning Input

Several measures recommended by the FWS to maximize the fishery benefits of the Hugo Lake project have shown positive results but others have not. On recommendation consistent with modern management practices was to allow existing timber and brush to be left standing in the reservoir basin. The CE constructed boat lanes in this extensive area of standing timber which constitutes approximately one-half the reservoir at conservation pool level. The resultant cover provides conditions for better growth and survival of species such as largemouth bass and crappie. The boat lanes provide fishermen access to areas in which fish are concentrated.

The recommendation to clear and chart seining areas was designed to allow commercial fishing. At present, state statutes do not permit commercial fishing at Hugo Lake, and there are no plans to utilize commercial fishing on Hugo as a fisheries management tool (personal communication, Kim Erickson, ODWC, Oklahoma City, 1977). In any event, commercial fishing on Hugo Lake is probably not economically feasible (personal communication, Jim Bottorff, FWS, Tulsa, 1978). In addition, problems were encountered in completely clearing the 393 ha of seining areas; these areas would have limited use in the future, as they were not completely cleared. The projected fishery benefits of 58,200 kg of commercial fish harvested within the reservoir have not been realized.

The recommendation to incorporate all-weather fishing walkways and berms with guardrails was accepted by the CE, and these structures were incorporated into spillway construction planning. The walkways were constructed. Guardrails, however, were never constructed.

Minimum instantaneous flows of 5.7 m^3 per second during December and January were recommended for the preservation of valuable stream resources in the lower reach of the Kiamichi River. The ODWC concurred with this recommendation, noting the possible benefits to sauger and walleye spawning. The CE agreed to releases of 4.3 m^3 per second during these months, maintaining that this discharge would serve the purposes intended in the recommendation. However, actual releases during December and January have generally exceeded 14.3 m^3 per second. It is impossible to determine if the 1,000 man-days attributed to this recommendation have actually occurred, as other factors affect the level of fisherman use. The ODWC creel census taken during the winter of 1974-1975 indicates 2,248 man-days of fishing took place during that time.

The U.S. Fish and Wildlife Service, Western Energy and Land Use Team (22), in a survey of 79 reservoirs where minimum instream flows downstream from the dam were implemented, has found that these flows consistently improved both fish habitat and fish populations. The FWS is apprehensive that the completion of Clayton Lake and implementation of the Central Oklahoma Water Conveyance System may reduce releases below Hugo to zero during several months of the year (personal communication, Jim Bottorff, FWS, Tulsa, 1978). The U.S. Fish and Wildlife Service data files for the Central Oklahoma Project (49) recommend minimum instream flows below Hugo Reservoir at between 14 and 43 m^3 per second. This

recommendation implies that the original 5.7 m^3 per second recommendation may not have been adequate.

The recommendation that a boat-launching ramp be provided as part of the proposed access downstream from the dam was accepted for consideration by the CE. The boat ramp was not constructed, presumably due to high costs associated with maintenance due to fluctuating water levels in the stilling basin (personal communication, James Holder, Corps of Engineers, Hugo, 1978). The absence of the boat ramps appears to have a substantial effect on the downstream fishery. The CE's Fish and Wildlife Management Plan, completed 15 September 1976, included this statement:

> Downstream fishing by boat at present is limited to small craft that can be loaded by hand. The absence of a boat ramp in this area encourages use of boats ill-matched to the turbulent waters encountered in the downstream area. Therefore consideration should be given to the construction of a boat ramp to minimize the danger by accomodating larger boats (p. 2-3).

It is apparent, therefore, that the absence of a boat ramp downstream from the dam detracts from both the safety of fishing activities and the quantity of fishermen use.

Of the recommendations listed in CE's Fish and Wildlife Management Plan, only three were implemented, and then only partially. Of the fish which the CE urged the ODWC to stock, all but the hybrid sunfish and Mississippi silversides were stocked. Mississippi silversides have established thenselves in the lake, probably by emmigration from other impoundments or through release by fishermen. Also attempts were made by the CE hydrology branch to stabilize water levels during spring spawning periods (personal communication, James Holder, CE, Hugo, 1978), but heavy rains during the spring have negated these efforts. The

project map of Hugo Lake shows tributary channels and boating lanes, but does not include lake contours as suggested.

The stake beds to concentrate crappie along the bluffs in the Kiamichi Park area were never constructed, although the CE cooperated with the Hugo Bassmaster Club in sinking discarded Christmas trees and marking them with a buoy (personal communication, James Holder, CE, Hugo, 1978). The Western Energy and Land Use Team (22) considers stake beds utilized for the concentration of game fish to be less effective and more expensive to install than alternate forms of cover. As stated previously, releases below the dam have only on a few occasions been less than 14 m^3 per second making the question of the feasability of 14 m^3 per second discharge in the summer months a moot point.

The predictions in the EIS concerning the composition of the fish population in Hugo Lake were accurate, with a few exceptions. None of the anglers sampled in the ODWC creel survey reported capturing a spotted bass. This species was also absent in the ODWC fish population survey, although the EIS had predicted that spotted bass would become the dominant black bass species in ecotonal areas. The largemouth bass, white crappie, and channel catfish have all flourished, as predicted. The dominant species in the lake has become the gizzard shad. Contrary to prediction, the species diversity of coarse fish has apparently decreased since impoundment (Table 6), although the pre-impoundment sample consisted of only three fish. Species diversity of forage fish apparently did decline (Table 6), as predicted by the EIS, but some of the species expected to be established, golden shiner, bigeye shiner, bluntnose minnow, blackband minnow, and logperch were not collected in the ODWC survey.

Table 6. Comparison of species diversity[a] of fishes in lower Kiamichi River, in 1972, prior to impoundment, and Hugo Reservoir in 1977.

Category	Species Diversity in Kiamichi River (1972)	Species Diversity in Hugo Reservoir (1977)
Sport	0.01	1.06
Pan	1.12	1.25
Coarse	0.55	0.52
Forage	1.81	0.80

[a] see text, page 24, for formula

Two unexpected occurrences, slow growth of largemouth bass and establishment of a significant white bass fishery very early in the life of the impoundment, were indicated by the ODWC fish population and creel surveys. Slightly below average growth rates of largemouth bass were possibly the result of elimination of threadfin shad from the lake by cold weather. Only passing mention was made in planning documents of a white bass fishery in Hugo Lake, although creel survey data and the ODWC fish survey showed them to be quite abundant after impoundment. Fisherman access to spawning runs of these fish in tributary creeks and the headwaters is limited, although limited access may be beneficial to the Migratory Bird Refuge and the Public Hunting Area.

The FWS has been criticized for its failure to include in its 1968 planning letter predictions for Hugo Lake in the second and third stages of proposed development (50). Although it is possible that the exclusion of stages two and three resulted from oversight or lack of manpower, it is quite probable that it occurred as a result of a letter from the CE, dated 7 July 1965, stating that the construction of Clayton and Tuskahoma Lakes were doubtful and should not be considered along with the Hugo project (51). Without construction of these lakes, stages two and three would not come into effect.

Estimation by the CE of the average annual minimum pool was 3,440 ha. This surface area was based on a water level at elevation 121 m. However, actual annual minimum pool occurred at 123 m during the first four years of impoundment. It is possible that under-estimation of man-days of fishing occurred as a result of under-estimation of lake size, although the basic data files do not exist to confirm this hypothesis.

Angling effort on the reservoir (29,174 man-days) falls short of

the anticipated level of 68,000 man-days predicted in the 1968 planning letter. One probable cause for this over-estimate was the assumption that the reservoir would attract anglers from throughout southeastern Oklahoma and northeastern Texas. There are nine CE-constructed reservoirs within 120 km (75 miles) of Hugo Lake, of which Millwood Lake and Broken Bow Lake are regionally famous as bass lakes. Questions concerning the angler's place of residence in the ODWC creel survey would have been of great value in determining the ability of Hugo Lake to attract anglers from longer distances.

Within the stilling basin, an estimated 22,007 man-days of fisherman use occurred. This number greatly exceeded the projection of 10,000 man-days made in the 1968 FWS report. The easy access from U.S. Route 70 and well-constructed facilities may be major reasons for the popularity of this area. The average fish caught in the stilling basin was somewhat small (0.29 kg), but fish were caught in relatively large numbers (1.37 fish/hour). A great majority of anglers in the stilling basin were local people, as evidenced by the 2.14 hour average for a completed trip.

Due to the absence of a boat ramp below the dam, a large portion of the additional 6,800 man-days projected for downstream fishery below the stilling basin have not been realized.

Wildlife Resources--Pre-impoundment

Wildlife Resources of the Hugo project area were described in the May 29, 1968 FWS report as follows:

> White-tailed deer are the only big game animals of significance in the project area. The oak-pine covered uplands and the dense bottomland hardwoods provide moderate to good

> deer habitat. Deer populations would increase during the period of analysis and provide about 1,500 man-days of hunting annually.
>
> Upland-game hunting for gray squirrels, fox squirrels, cottontails, swamp rabbits, bobwhites, and doves is important locally. The hardwoods and dense growth of vegetation along the Kiamichi River and its tributaries provide excellent habitat for the above species with the exception of the bobwhites. During the period of analysis, upland game would provide about 4,600 man-days of hunting annually.
>
> The Kiamichi River floodplain receives moderate waterfowl use. Wood ducks nest and winter in the bottomlands and, during years when flooding coincides with good oak mast production, exceptionally heavy concentrations of ducks, especially mallards, use the area. When such conditions are prevalant during the waterfowl hunting season, some of the finest duck hunting in the state is realized by those hunters who have access to the flooded timber flats along the Kiamichi River. Without the project, it is expected that these conditions would continue and waterfowl would provide an estimated 1,600 man-days of hunting annually.
>
> Other wildlife indigenous to the excellent habitat in the project area include raccoons, opossums, gray foxes, coyotes, and crows. Hunting dogs as well as various manufacture calls are used extensively in pursuit of the above species. Hunting for these species is increasing and is exceeded only by upland game in popularity. Without the project, these species would support about 2,200 man-days of hunting annually. Trapping for the raccoons, opossums, gray foxes, and coyotes would yield about 900 pelts annually (p. 7).

Methodology used to make projections of recreational hunting use are contained in the following passage from the 1968 FWS report:

> Evaluation of fish and wildlife resources are based upon a 100-year period of analysis and consider the hunting and fishing demands anticipated for the area based on the population that will reside within a day-use distance from the project site (p. 4).

However, due to the volume of records generated by the Tulsa field office of the FWS and limited space, records which are sometimes referred to as "basic data files" are not available for the Hugo Lake project.

Big game statistics (52) show that legal harvest of deer have in

the past been extremely low, averaging less than seven deer annually between 1956 and 1970. Kills reached a peak countywide in 1971 with 41 deer harvested. In 1972 and 1973 deer kills were 29 and 23, respectively. Legal deer kills in Pushmataha County average 236 annually between 1956 and 1970. In 1971, 1972, and 1973 deer kills were 267, 318, and 240, respectively. ODWC personnel could not estimate what percentage of this harvest might be attributed to the Kiamichi River bottomlands within the project area. No pre-impoundment quantitative data regarding either upland game, waterfowl, or miscellaneous species for the Hugo Lake area is available (personal communication, Byron Moser, acting Chief of Game, ODWC, Oklahoma City, 1978).

The expected impact of Hugo Lake on wildlife habitat was included in the 1968 FWS report:

> Approximately 21,100 acres (8,546 ha) of moderate to excellent habitat in the reservoir site will be lost through inundation, project construction, operation, and human disturbances. In addition, the value of about 5,000 acres (2,025 ha) in the downstream floodplain will be reduced because of more intensive agricultural and other land use changes made possible by protection of the area from floods (p. 8).

The effects of the impoundment were expected to reduce significantly both deer and upland game populations. Inundation of habitat and reduction of den and food-producing trees were the major reasons for the expected decline. With the project, estimates of hunting use were 600 man-days for deer and 2,800 for upland game. Loss of habitat was also expected to adversely affect hunting for the other wildlife such as raccoons, opossums, foxes, coyotes, and crows. Hunting for these species would be reduced to 1,000 man-days and pelts taken by trapping to 500 annually.

The 1968 FWS report included the following predictions relating to waterfowl:

> Initially, waterfowl use of the reservoir will be substantial with large numbers of ducks and geese using the reservoir for resting during the spring and fall migrations. In addition, waterfowl will feed in the seasonally flooded bottomland areas of the reservoir. The constant flooding will, however, destroy the mast-producing trees and other vegetation important for waterfowl food that will occur within the reservoir flood pool. Hunting losses resulting from the flooding of bottomland habitat will be negated by increased hunting along the perimeter of the reservoir. The overall effect will be that waterfowl hunting will remain about the same as without the project, 1,600 man-days annually (p. 9).

Waterfowl in the past have utilized the Red River valley not only as a resting area on migration flights, but also as a wintering area when weather conditions permitted. However, land conversion had resulted in former lowlands and marshes being replaced by agricultural land, which has in turn resulted in decreased waterfowl populations.

In addition, the amount of waterfowl-supporting lands at the Tishomingo National Wildlife Refuge, 161 km west of Hugo Lake, was dwindling. The continued siltation of the Washita River in the Tishomingo Refuge had greatly reduced the available farming lands in the surrounding area. Siltation was expected to reduce the amount of lands on which waterfowl food could be produced to the extent that farming practices may be abandoned entirely. The Tishomingo Refuge in early 1974 was carrying water levels 0.6 m or more above those of the normal Lake Texoma elevation because of silt plugs in the Cumberland Cut. This problem was expected to continue to have an adverse effect on the area's capability of producing food crops and attracting geese and other waterfowl. Compounding the problem, from a waterfowl flyway standpoint, was the absence of refuges between southern Oklahoma and the

Texas coast. Prior to impoundment, therefore, a great need was seen for the waterfowl habitat in the Hugo Lake area.

The EIS for Hugo Lake, released in February, 1974, makes this prediction concerning waterfowl:

> The numbers of waterfowl to utilize the area will depend to a significant degree on the management procedures to be incorporated on the National Wildlife Refuge to be administered by the Bureau of Sport Fisheries and Wildlife. Grain crops raised on part of these areas will need to be managed to ensure that significant crop degradations do not occur as a result of ducks and geese in the surrounding farm lands; appropriate planning of such crops can also lead to significantly higher utilization of Hugo Lake by waterfowl. Wood ducks may increase in numbers and breed near the edges of the lake, but whether or not this will be in significant numbers will depend on the extent to which (in time and height) water levels fluctuate and if management practices provide for the best boxes and appropriate habitat management (p. 3-34).

Wildlife Resources--Post Impoundment

The Oklahoma Department of Wildlife Conservation began active management of the 7,369 ha of land allocated for license as a State Game Management Area and Migratory Bird Refuge (GMA) on 7 November 1975. The remaining acquired lands above conservation pool level, approximately 3,290 ha, is being administered by the CE as eight wildlife management units varying in size from 225 to 624 ha. The ODWC had submitted a General Management Plan for the Hugo GMA to the CE and FWS on 2 May 1975. The CE completed their Fish and Wildlife Management Plan on 15 September 1976.

The ODWC received a "right of entry" letter to begin management on project lands on 23 May 1975. The GMA manager began residence near the project area in November 1975. Flooding which had occurred throughout 1974 and 1975 killed most trees in lower project areas, substan-

tially destroying much of the capacity for greentree reservoir management (personal communication, David Robertson, ODWC, Hugo, 1978).

During the last months of 1975, activities on the GMA consisted of fencing boundaries, rebuilding roads, installing drain pipes, and erecting public hunting signs (53). These activities continued throughout the winter and early spring. In addition, approximately 608 ha of land underwent a controlled burn and survey work for three small impoundments totaling 81 ha was completed. During 1976, 1977, and early 1978, additional measures have been implemented (54) (55). Five dike units between 915 and 1,220 meters in length with an average height of 1.2 m were completed. Water control structures were included. Eighteen and one-half kilometers of new fence were constructed. Bridge and road maintenance has occurred. Approximately 9 km of new roads have been constructed. Eighty-one hectares of mud flats have been seeded to Japanese millet. An additional 1,216 ha of dense vegetation underwent controlled burns. Numerous boundary signs and directional signs have been erected. Of the total 7,369 ha administered by the ODWC, 5,940 ha were opened to public hunting. The remaining 1,429 ha were designated as a migratory bird refuge.

Wildlife-related improvements made on project lands administered by the CE (49) include 17 ha of food plots, brush piles, 14.2 ha of wildflowers, 20 woodcock use sites, nesting boxes for wood ducks and squirrels, wetlands developments, bird feeding stations, nature trail and blind developments, and multiflora rose and lespedeza plantings.

The 1977 CE Annual Narrative Report for Hugo Lake included these observations regarding wildlife:

> The duck population this season has been fair. The smaller population this year is due to the low pool elevation during the fall and winter months, combined with above normal temperatures.
>
> The Oklahoma State Wildlife Conservation Department has begun share-cropping and development of wildlife food plots in the game management area and has completed work on four green tree reservoirs. This should provide for a steady duck population during the hunting season and attract geese (p. 2).
>
> Upland game has only been fair. Overgrazing and a lack of winter food has been the chief contributor of this condition. The additional share-cropping fields should provide additional food.

The level of waterfowl use of State administered lands at Hugo Lake is documented in the Federal Aid progress reports on migratory birds, Project W-32-R-26 (56) and Project W-32-R-27 (57). One-day aerial counts made during the winter of 1975-76 estimated the duck population at 3,700. Ground observations during a 15-week period during this season estimated average daily duck use at 2,888. One-day aerial counts made during the winter of 1976-77 indicated a population of only 900 ducks. Ground observations during a 15-week period estimated average daily use at 2,759, a decrease of 5% from 1975-76.

Surveys by ODWC personnel indicate that there are three flocks of turkeys established on project lands or its periphery (personal communication, Byron Moser, ODWC, 1978). Two flocks are estimated to contain less than 10 birds, and the third flock contains 10 to 20 birds. Six turkeys and 650 quail have been stocked in the GMA since November 1975. No additional data are available concerning the status of upland game, big game, or furbearer populations other than harvest data.

Harvest data collected within the GMA from November 1975 to June 1976 is minimal (Table 7). Duck hunters who were sampled hunted 49.5

hours and harvested 68 ducks, an average of 4.8 ducks per hunter and 1.4 ducks per hour. Hunting for quail, deer, squirrel, rabbit, and dove was infrequent or non-existent during this time period. Four hunters spent 50 hours pursuing furbearers, harvesting 40 animals.

Harvest data collected from July 1976 to June 1977 indicate increased hunter use (Table 7). Duck hunters sampled hunted 436 hours and harvested 366 ducks, 3.3 ducks per hunter and 0.8 ducks per hour. Squirrel hunting appeared to increase from the previous year. Furbearer hunting increased and 73 animals were harvested, an increase of 33 from the previous year. Two deer were harvested on the GMA in each of the 1975 and 1976 seasons.

CE estimates of recreational use of project lands, derived from a system of traffic counters established at entrances to various access points plus speculations of recreational use of remote areas, were made in 1977 (48). Approximately 133,800 persons visited the project in 1977 during the months of January, October, November, and December. Using a coefficient of .25 as an estimate of the percentage of individuals engaged in hunting yielded a total of 32,800 hunter trips.

According to the ODWC (58), land use practices prior to the reservoir development were probably the cause for habitat deterioration, and the resulting low numbers of upland game and forest game populations which existed in 1975. The CE's Annual Narrative Report for Hugo Lake documents the continuing grazing problems on project lands in the following passage:

> A significant problem at Hugo Lake in regard to resource management has been unauthorized livestock grazing. In order to correct the problem, a grazing plan for Corps low density areas has been prepared with assistance from local Soil Conservation Service personnel.

Table 7. Hunter use and success on Hugo GMA (Public Hunting Area) during 1975-76 and 1976-77 seasons.

Species	Number of Hunters		Harvest		Hours Hunted	
	1975	1976	1975	1976	1975	1976
Ducks	14	111	68	366	49.5	436
Bobwhite Quail	9	22	5	22	20	28
Deer	4	5	2	2	10	12
Squirrel (May,June)	13	16	28	40	37.5	45
Rabbit	0	6	0	11	0	18
Dove	0	0	0	0	0	0
Furbearers	4	5			50	100
Opossum			21	18		
Raccoon			8	20		
Beaver			1	0		
Coyote			8	25		
Bobcats			2	10		
Totals	44	165	163	514	167	639

> The plan provides for grazing from November through April. Leases were begun 1 January 1977. Temporary grazing leases are being arranged to alleviate grazing problems in the Oklahoma State Wildlife Management Area (p. 2).

U.S. Fish and Wildlife data files concerning the Central Oklahoma Project (49) contained this statement concerning post-impoundment wildlife resources at Hugo Lake which may not be totally warranted in light of the previous statements:

> Upland game numbers are high due to habitat manipulation practices that benefit these much sought after species. Squirrels, both fox and gray, are found on 9,100 acres (3,686 ha) in the area. Although good swamp rabbit habitat is rapidly disappearing in Oklahoma, Hugo Game Management Area assures a controlled unit of 8,400 acres (3,402 ha) for this species and the cottontail. Bobwhites have readily responded to the management practices on their 5,250 acres (2,126 ha) of primary habitat. Although mourning dove habitat is not as extensive as that of other upland species, the cropping and burning practices have created 3,500 acres (1,418 ha) of dove range.

Wildlife Resources--Evaluation of Planning Input

The FWS planning letter of 29 May 1968 was formulated with apparently adequate time for development. The CE had not made significant engineering modifications since January 1961. Although the 1968 report correctly identified problem areas associated with the project, much of the treatment of wildlife was superficial. Several of the planning recommendations affecting wildlife were implemented, but non-implementation of the recommendation to establish a national wildlife refuge has had the most effect on wildlife resources of the project. Degree of success for implemented measures was extremely difficult to to assess.

Minimum instantaneous flows, which were discussed in the fishery

resources sections, were accepted by the CE at 4.3 m^3 per second. These flows may have a stabilizing effect on wildlife communities below the dam.

Retention of timber, also discussed in the fishery resources section, was implemented by the CE. This measure reduces wind and wave action and therefore reduces shoreline erosion, leaving standing trees and shrubs within and near the bounds of reservoir pools, preserves cover, breeding, and resting areas for upland game, big game, and songbirds.

The recommendation that the project be zoned for public use was accepted and implemented. Zoning ensures that conflicts among uses in the project will be minimized. For wildlife, established areas are protected from uses that are inimical to wildlife habitat and production. On reservoir water, zoning may be used to protect wildlife breeding areas from disturbances from water surface recreational uses.

The recommendation that boundaries of all project lands be marked according to zoned areas was considered, and has been completed in some areas. The CE is presently administering a grazing lease program in which (for a nominal fee) the rancher leasing the property erects the fence from material provided by the State (personal communication, James Holder, CE, Hugo, 1978). This program is limited by the number of persons willing to lease the land and availability of State funds for fencing materials. Since project land acquisition, uncontrolled grazing has resulted in continuing wildlife habitat deterioration.

Funding for fencing on State Game Management Area lands has been an issue of continuing disagreement and illustrates a lack of cooperation between agencies. The FWS believes that intensive wildlife manage-

ment on development projects is planned as a measure to mitigate project-caused losses to wildlife resources. Without project-provided fencing the mitigation measures were considered by the FWS to be incomplete. These views were expressed in a review of the final Hugo EIS (59). The Corps responded by arguing that the State Game Management Area near a well-developed national wildlife refuge should be highly complementary to wildlife utilization and conservation. According to the CE, only minimum supervision and management on State lands would be required to capture full wildlife benefits associated with these lands (59).

The FWS does not accept the CE's response as legitimate. The Department of Interior had expressed concern over this issue as early as 6 July 1962 in a letter to the CE (60). Part of this letter follows:

> This department does not believe that an evaluation of the losses prevented by installation of such measures is required. Further, we believe that it is unnecessary to derive a monetary benefit/cost ratio for these measures since no 'benefits', as such, are created. The value of losses prevented should be considered at least equal to the cost of mitigation measures. In accordance with section 2(c) of the Fish and Wildlife Coordination Act, the cost of mitigation measures should be an integral part of the cost of the project. This reasoning is consistent with subparagraph 10a (1) Corps of Engineers EM 1165-2-104 (p. 3).

Also included in the FWS review of the final EIS for Hugo Lake was the following further discussion of funding for fencing on State lands:

> In any area where livestock grazing is prevalant, intensive wildlife management is impossible without good control of grazing use. This means that fencing is a necessity. Where 3,000 to 4,000 acres (1,215 to 1,600 ha) of land are to be managed for wildlife in order to compensate for the loss of wildlife and hunting on more than 18,000 acres (7,290 ha) of land, it is obvious that very intensive management of the smaller area would be required to realize worthwhile mitigation. Wildlife production must be tripled or quadrupled and public use must be so handled that wildlife production would not be impaired. At the same time, public

> use must be greatly increased so that utility of the smaller area is somewhat near that of the larger area.
>
> The Fish and Wildlife Service believes that mitigation facilities and works should be turned over to the State in 'turn-key' condition. Management expenses to the State should be no greater than the expense incurred by the State on the area which the mitigation area replaces. If such expenses are greater, then operation, maintenance, and replacement costs should be provided from project funding. It is unrealistic to expect the states to continue to assume the costs of wildlife management needs created by Federal projects.
>
> It appears to the Department of the Interior that the Corps of Engineers has failed to comply with the spirit and intent of the Fish and Wildlife Coordination Act and the National Environmental Policy Act of 1969 (Public Law 91-190) regarding the provision of suitable wildlife migratory works at Hugo Lake, Oklahoma. Until this matter is satisfactorily resolved, adequate mitigation of fish and wildlife resources cannot be realized. This thought should be incorporated in the Environmental Impact Statement (p. 4).

It was not.

The recommendation that 7,290 ha of project land and water be made available to the Bureau of Sport Fisheries and Wildlife for the establishment of a national wildlife refuge was accepted by the CE. The CE remained neutral throughout the entire refuge controversy but made many efforts to encourage a speedy settlement satisfactory to both the FWS and the ODWC.

During the early stages of planning for Hugo Lake, a study was made by the FWS in cooperation with the ODWC under provision of the Fish and Wildlife Coordination Act. It was determined that the Hugo Lake project had particular value to the national waterfowl resource management program, and it was recommended that a national wildlife refuge be established on the project (61). The ODWC had also selected a portion of the project for game management purposes. These recom-

mendations were contained in the 1968 FWS report to the CE. Wendell Beaver, the Director of the ODWC, concurred with this report on 10 April 1968. Between January 1973 and May 1975, numerous meetings between representatives of the FWS and ODWC were held in an effort to satisfy plans and responsibilities for wildlife management of both agencies.

In October 1973, the FWS withdrew recommendations for establishment of a 4,860 ha Federal wildlife refuge at Kaw Reservoir in northern Oklahoma so that the ODWC could manage all of the 16,000 acres (6,480 ha) intended for wildlife purposes. It was understood by the FWS that in return the State would support establishment of a Federal refuge at Hugo Lake (62). The State subsequently requested reconsideration of the original proposal for Hugo Lake, which included a national wildlife refuge. Several proposals by the FWS to turn over portions of land originally intended for the national wildlife refuge to the State were rejected. The State maintained that more liberal hunting conditions could be applied if they were given full control of the lands on the Hugo project (63). In addition, the State wished to assume management of project lands because these lands could be developed to include greentree reservoirs, a situation unusual within Oklahoma. Wildlife Commissioner Lyndol Fry maintained that ". . . in the long run, we can offer the people the best facility in the State" (63). Project lands were visualized as being a "showcase" of greentree reservoir management. Greentree reservoirs are bottomland hardwood areas shallowly flooded for short periods during the dormant growth period for the purpose of attracting waterfowl. Short-term flooding allows waterfowl to feed on mast from various oaks. This food source is supplemented by understory food plants such as wild millet and smartweed. The Hugo project

has the flat areas with impervious clay soils, mast-bearing oaks, and a water supply from a low-gradient body of water that are required for greentree reservoirs.

In May 1975, the FWS began procedures to forego administration of the proposed national wildlife refuge in favor of ODWC administration (44). Several of the factors entering into this decision were: 1) possible ill-feelings in the town of Hugo generated by the refuge controversy; 2) fluctuating water levels flooding much of the proposed farm land several time per year; 3) drainage problems due to clay soils requiring leveling and diking; 4) uncontrolled hunting in the project area due to lack of fencing; 5) uncontrolled grazing.

Estimates of expenditures for the proposed Federal refuge at Hugo Lake were $765,000 for development and $80,000 annually for administration (59). Total estimated costs for the Hugo GMA in 1975 were $87,700 for development and $60,400 for maintenance during the period 1 August 1975 to 30 June 1980 (58).

In order to further evaluate the effect that total State administration of wildlife mitigation lands rather than the establishment of the proposed national wildlife refuge may have had, a comparison was made between the Hugo GMA and Sequoyah and Tishomingo National Wildlife Refuges (NWR). Tishomingo NWR is located approximately 130 km west of the Hugo GMA, and Sequoyah is approximately 260 km north of the Hugo GMA. Tishomingo NWR was chosen for comparison due to its geographical proximity, and Sequoyah NWR was chosen because it is relatively new, established in 1970. Hugo GMA was established in 1975. All three areas are managed principly for waterfowl. Both Federal refuges are similar in size to Hugo GMA. Tishomingo NWR is 6,668 ha,

Sequoyah is 8,424 ha, and Hugo GMA is 7,370 ha.

Annual expenditures and manpower for Hugo GMA are at much lower levels than at Sequoyah NWR and Tishomingo NWR (Table 8). Simply stated, the ODWC does not have the financial and manpower capabilities of the National Wildlife Refuge System. The limited income of the ODWC "precludes intensive or extensive development for wildlife production" (64). The ODWC had an average annual income from all sources of 3.05 million dollars over the period 1962-1969. Total lands administered by the ODWC in 1973 were 561,000 acres (227,205 ha), of which 11 areas covering 156,508 acres (63,386 ha) were licensed from the CE.

The two Federal Refuges appear far superior in terms of ability to attract ducks (Table 9), although it should be remembered that the Hugo GMA was established in 1975. The Federal refuges also attract many more geese than the Hugo GMA. During the 1976-77 season, Tishomingo NWR provided over three million goose-use days and Sequoyah NWR provided over one million. Although a few geese utilize the Hugo GMA, no geese were observed on the Hugo GMA during one-day aerial surveys in 1976 and 1977.

The procedures by which FWS estimates hunter use during pre-construction planning has been increasingly refined since 1968. Hunting man-days of use are currently estimated by calculating the total area of habitat available for a given species and multiplying this figure by the density of animals, based upon figures in the literature (personal communication, Jim Bottorff, Ecological Services, Tulsa, 1978). The density of the animals is a function of the quality of the habitat. Using the estimated population of animals, a total harvest figure is obtained by multiplying by a percentage kill figure taken from the available literature. The total harvest is multiplied

Table 8. Acreage, 1977 Budgets, and Manpower of Hugo GMA, Tishomingo NWR, and Sequoyah NWR.

	Hugo GMA	Sequoyah NWR	Tishomingo NWR
1977 Budget	$44,500	$119,800	$246,500
1977 Manpower	1 full-time plus 200 hrs. part-time	4 full-time 2 part-time	10 full-time
Size (ha)	7,390	8,424	6,668

Table 9. Average daily duck use of Hugo GMA, Sequoyah NWR, and Tishomingo NWR in 1975-76 and 1976-77

	Hugo GMA	Sequoyah NWR	Tishomingo NWR
1975-76	2,888	26,307	34,259
1976-77	2,759	14,937	23,112

by the expected man-days per kill to yield the total man-days of hunting to be provided by the land area. This figure is then compared to the number of hunters residing within a day-use distance of the project site. Predictions are therefore based both on population of an area and the ability of a given area to sustain a certain amount of hunting.

The estimate of 32,800 hunter trips, based on numbers of vehicles recorded by the CE, is unrealistically high. The estimate of 25% of visitors participating in hunting probably leads to this over-estimate of total use. It is also possible that the load factor, which is the estimate of persons per vehicle, over-estimates the numbers of persons visiting the project. Hunting statistics developed independently by the CE at the Council Grove Lake project in Kansas were found to be 21 times higher than comparable estimates by the Kansas Forestry, Fish, and Game Commission (38).

As previously mentioned, complete mitigation for wildlife losses may not be possible to develop on land areas of a different type and smaller area than the original habitat which was lost through inundation. Were the original planning for Hugo Lake being done today, the FWS would press for acquisition of bottomlands outside the project area, in either the Red River or Kiamichi River valleys (personal communication, Jim Bottorff, FWS, Tulsa, 1978). These areas would replace the inundated lands only if funds were provided to increase productivity by a factor equal to that lost by inundation.

Recommendations

Coordination of agency responsibilities for fish and wildlife planning is complicated by the complex nature of ecological systems and the period of time required to analyze the effects of a given aspect of development. Frequently the agencies responsible for fish and wildlife conservation have insufficient time and/or manpower to carry out these analyses. FWS manpower needed to gather baseline data on development projects, including Hugo Lake, were often limited at the Tulsa Regional Field Office (personal communication, Harvey Rogers, FWS, Tulsa, 1978).

In general, the time allotted for planning for fish and wildlife at Hugo Lake at first appeared to be sufficient. However, time shortages did have adverse effects on planning. A study of the feasibility and desirability of a national wildlife refuge at Hugo Lake was begun in 1966, but formal objections to its creation did not surface until January 1973. Development of wildlife management measures for this area was preempted and the possibility for much greentree reservoir management was lost when the reservoir was flooded before diking could be accomplished.

Due to the eventual rejection of plans for national wildlife refuges at Kaw and Hugo Lakes in favor of management by the state, an annual inflow of approximately 400,000 dollars for wildlife management activities from the Federal government was lost to local economies in the State of Oklahoma. The figure of 400,000 dollars is based on the difference between what the state currently spends at Kaw and Hugo Lakes and typical expenditures for national wildlife refuges in

Oklahoma. Currently wildlife management measures at Hugo Lake are less extensive than projected expenditures under the Federal refuge proposal might have provided. The low expenditure for wildlife mitigation at Hugo Lake can be attributed to lack of funds in general. The Corps of Engineers does not feel justified in mitigating all losses to fish and wildlife resources when this mitigation involves funding for intensive management, and the state does not have sufficient monies to underwrite the costs of mitigation.

In view of these problems, as well as others apparent at Hugo Lake, the following recommendation are made:

1. Planning for mitigation and conservation of fish and wildlife resources should begin prior to authorization of the development project;
2. Sufficient funding and manpower should be provided for all participating agencies for the gathering of baseline ecological data at project expense;
3. An approved fish and wildlife management plan should be on file with the construction agency prior to project implementation, and that agency should be responsible for integration of construction aspects of that plan with overall project construction;
4. The development agency should provide funds for development, operation, and maintenance of wildlife areas when needed for complete mitigation of losses;
5. The Fish and Wildlife Coordination Act should be amended to eliminate the development agency as sole arbiter of measures needed for wildlife purposes;

6. A plan to provide post-impoundment evaluation of fish and wildlife planning should be completed prior to construction of the development project.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The amended Fish and Wildlife Coordination Act (1958) requires water development agencies to consult with the agencies responsible for fish and wildlife resources in order to prevent loss of and damage to such resources (2). In addition, the development agency must prepare a project plan which provides justifiable means and measures for fish and wildlife purposes as needed to obtain maximum overall project benefits. The reporting agency (CE) determines the justifiability of wildlife conservation measures. The Secretary of Interior is required to provide the development agency specific recommendations and predictions describing damage to wildlife attributable to the project and measures proposed to mitigate or compensate for these damages.

The original planning for wildlife mitigation anticipated approximately 7,290 ha of land utilized for a national wildlife refuge, and an adjoining State game management area of 2,390 ha. Due to political situations beyond the control of the CE and FWS, the State of Oklahoma eventually assumed administration of 7,370 ha of mitigation lands. The cost of the wildlife habitat development and maintenance program for these frequently-flooded lands has not been shared by the federal program which caused the original wildlife losses. These lands are difficult to manage due to drainage problems and have suffered damage due to poor land use practices in the past. The FWS is of the

the opinion that the level of intensive management needed to compensate for project-incurred terrestrial wildlife losses is not possible on project lands administered by the State, especially considering levels of funding. Additional lands outside the project of the type that formerly existed in the Kiamichi River bottom would be required for adequate mitigation.

Requests for fencing on ODWC administered lands were rejected by the construction agency. Their reason was that "benefits" associated with this habitat improvement measure did not justify the cost. The FWS did not regard the recovery of lost habitat and improvement of wildlife populations and hunting opportunities as "benefits" but rather as necessary compensation for damages incurred.

The Fish and Wildlife Coordination Act report submitted by the FWS in 1968 included recommendations that were not detailed enough to allow developmental or operational features of the project that will provide comprehensive mitigation. The report did not include consideration of occurrences associated with stages II and III of Developmental changes in Hugo Reservoir.

The non-implementation of the recommendations for the national wildlife refuge appears to have had a deleterious effect on wildlife resources, while failure to construct a boat ramp in the downstream section of the river has limited angler use.

The accuracy of specific predictions, for which post-impoundment data of sufficient scope permit evaluation, appear to have been good in some cases and poor in others. Although a diverse fishery of good quality has developed at Hugo Lake, the prediction of 84,800 man-days of use has not been realized. Actual fisherman-days in the future

may decline due to an increase of impounded water in the immediate vicinity and the relative decrease of gamefish populations as the impoundment ages. Future changes, however, in human population trends could alter this prediction. Hunting benefits on project lands appear to be less than the predicted 6,500 man-days of use and 500 pelts harvested, although hunting use is increasing. Improvement of wildlife populations, particularly waterfowl and upland game, has been slow due to the delayed start of management measures, habitat destruction due to flooding, severe and continued overgrazing, and limited funding for wildlife management.

Fishing effort statistics developed independently by the CE were found to be approximately 5.2 times greater than comparable estimates developed by the ODWC. Estimates for hunting by the CE also appear unrealistically high.

Prospects for the Future

The range of demands placed on reservoirs is broad, including agriculture, industrial and domestic needs, energy, flood control and recreation. Increasingly, plans for integrated development have been constructed with consideration of entire river basins. However, planning often fails to completely account for ecological effects of water resource development projects.

Gilbert White (72) in 1972 summarized the urgent need for reorientation of river basin projects:

> A puzzling aspect of many development projects is why they are not accompanied by more searching scientific investigation of their ecological consequences. To what conditions can we trace the lack of attention given to fisheries studies in a hydroelectric reservoir project?

> The same question can be directed to irrigation projects and schistosimiasis, flood control schemes and soils, the effects of pesticides or fire control, and a host of other relationships . . . Whatever the corrective measures, we are not doing conspicuously well with them. There is good reason to think that development projects are spreading faster than efforts to anticipate their full consequences (p. 542).

In the face of increasing numbers of water development projects, it is imperative that efforts be made to anticipate their increased consequences. If the ability to predict ecological consequences can be sufficiently developed, preventive planning can then be employed. Hopefully, through preventive planning based on research and careful collection of pre-impoundment data, the majority of adverse effects on fish and wildlife can be avoided or reduced. This planning will often involve modification of project design and improved management of project and surrounding lands. As the effects of preventive planning for fish and wildlife are continuously reviewed, more effective measures to mitigate wildlife losses due to development can be employed. Only when complete mitigation has been accomplished can true enhancement, creation of economic benefits, be realized.

Planning is essential to the process of fish and wildlife conservation because the costs of correcting damage to an ecosystem usually far exceed the costs of preventing it. The ability to predict ecological consequences of water resource development, however, is not the only ingredient of successful planning. Interagency communication and cooperation is essential so that planning is not done at cross-purposes. Smith (66) reviewed the case of fishery management efforts of the Laurentian Great Lakes, where over fifty years of extensive research and management failed to prevent deterioration of the fishery.

Successful application of theory and research have always been impeded by lack of coordination among some 30-40 state, provincial, and federal governmental units having varying degrees of influence on the fishery programs of the Great Lakes.

In order to have an effective coordination process, efforts must be made to include input from fish and wildlife agencies from the outset of development planning. Wildlife agencies should participate in planning prior to authorization of the project. Recommendations by wildlife agencies should be specific enough to ensure optimum mitigation. Predictions should be similarly detailed. Enhancement possibilities should be identified and reported regardless of agency disputes, so that the Congress and other approval authorities can consider them.

A plan to require follow-up after development to determine whether adequate provisions for wildlife have been made is essential. Such a plan would not only encourage enforcement of the Fish and Wildlife Coordination Act, but also ensure that pre-impoundment surveys were adequate to allow consideration of all possibilities for fish and wildlife mitigation and enhancement.

If people dedicated to preservation of our natural resources are able to bring about the results envisioned by the previous recommendations, we may be able to prevent much of the loss of our natural systems.

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APPENDIXES

APPENDIX A

CHRONOLOGY OF EVENTS

1) 17 August, 1956. R. A. Schmidt, Regional Director, Office of River Basin Studies, FWS, issued intra-agency memo stating that his office cannot provide FWS policy on the Hugo Project.

2) 11 February, 1957. FSW issued statement withholding recommendations until determination of authorized damsite is made.

3) 4 September, 1957. Public hearing concerning construction of Hugo Reservior was held.

4) 12 February, 1958. FWS issued a narrative statement of the quality of the fish and wildlife resources of the Kiamichi watershed.

5) 31 August, 1959. Corps of Engineers requested data for alternate plans for Hugo damsites from the FWS.

6) 25 September, 1959. Corps of Engineers requested that the FWS Service submit report by February, 1960.

7) 28 September, 1959. FWS was informed by the Corps of alternate plans for one reservior and for a 3 reservoir system.

8) 13 April, 1960. Corps of Engineers held meeting to announce that damsite had been relocated and that the size of construction features were still indefinite.

9) 22 April, 1960. Draft of preliminary fish and wildlife report submitted to Corps by USFWS.

10) 26 May, 1960. ODWC concurred with draft fish and wildlife report.

11) 1 June, 1960. FWS interoffice memo suggested that mitigation lands be purchased either at Clayton, or along Kiamichi below the dam, or among Red River bottomlands.

12) 6 June, 1960. Preliminary fish and wildlife report submitted to Corps by FWS.

13) 11 January, 1961. Minor adjustments were made by Corps in plans for flood control storage. Corps requested comments or supplemental reports from FWS prior to February 17, 1961.

14) 21 February, 1961. Draft copy of supplemental report submitted by FWS to Corps.

15) 6 March, 1961. Corps informed FWS that a single reservoir at Hugo would require 10,000 acre-feet of storage for a downstream release of 20 cfs.

16) 22 March, 1961. Final supplemental fish and wildlife report regarding revised engineering specifications for the Hugo dam was sent to the Corps by the FWS.

17) 28 March, 1961. Corps received supplemental report from the FWS.

18) 18 October, 1961. FWS issued comments on the Corps' proposed Survey Report.

19) 4 December, 1961. Corps of Engineers issued Survey Report on Hugo.

20) 2 May, 1962. FWS prepared a resume of problems with the Corps of Engineers.

21) 20 June, 1962. FWS objected to apparent disregard by the Corps of recreational-use data developed in the fish and wildlife report.

22) 12 October, 1964. The possibility of a National Wildlife Refuge was raised by the FWS.

23) 7 July, 1965. Corps of Engineers stated that the Clayton and Tuskahoma Reservoirs were doubtful and should not be considered along with the Hugo project.

24) 2 September, 1965. The eventual pool levels were announced by the Corps.

25) 8 October, 1965. FWS announced a study of the possibility of a National Wildlife Refuge on Hugo Lake.

26) 8 June, 1966. FWS informed the CE that a National Wildlife Refuge of 15,000 to 20,000 acres could be established in the Hugo area in a geographical position beneficial to the General Flyway.

27) 20 September, 1966. Estimates of hunting and fishing recreational use with and without the project were issued by the FWS.

28) 4 August, 1967. Corps of Engineers announced a land acquisition meeting to be held Sept. 22.

29) 22 August, 1967. FWS issued a proposal for the Kiamichi National Wildlife Refuge.

30) 22 September, 1967. A land acquisition hearing was held by the CE.

31) 27 September, 1967. FWS interoffice memo explained the positioning of the boundary between the proposed National Wildlife Refuge and waters open to unrestricted use.

32) 21 November, 1967. FWS interoffice memo indicated that report to Corps on National Wildlife Refuge was overdue.

33) 7 February, 1968. FWS sent copies of draft fish and wildlife report to ODWC, Corps of Engineers, Federal Water Pollution Control Administration, and Bureau of Commericial Fisheries.

34) 13 February, 1968. Public meeting concerning Hugo Lake was held.

35) 4 March, 1968. Federal Water Pollution Control Administration noted that three-stage development was not considered in the draft fish and wildlife report. In addition, it was noted that low flow releases in December and January could cause summer releases to be inadequate.

36) 4 March, 1968. CE requested input from FWS and ODWC for development of a detailed plan for reservoir clearing.

37) 5 March, 1968. CE received draft of fish and wildlife report for Hugo Lake from FWS. CE informed FWS that the boundaries for refuge and game management areas exceeded project lands.

38) 14 March, 1968. W. Bever (ODWC) requested 30 more days to review draft of fish and wildlife report.

39) 28 March, 1968. FWS made recommendations to CE concerning clearing of timber.

40) 10 April, 1968. ODWC approved draft fish and wildlife report.

41) 2 May, 1968. CE sent clearing plans to FWS and ODWC. These plans included boat lanes to be incorporated into uncleared areas.

42) 29 May, 1968. FWS released final fish and wildlife report to CE.

43) 14 December, 1970. CE requested input from FWS on planning of public-use sites.

44) 6 January, 1971. Leland Roberts (ODWC) concurred with deletion of timber clearing from portions of two seining areas.

45) 3 February, 1971. CE informed FWS that zoning maps were being prepared for Rattan Landing and Frazier Point public-use areas.

46) 3 February, 1971. CE requested ODWC response to zoning plans.

47) 3 May, 1971. FWS requested that Corps restrict Frazier Point to day use only and that Rattan Landing have no camping or boat launching facilities.

48) 3 May, 1971. Farrell Copelin (ODWC) concurred with Corps' zoning plan and requested that public hunting be allowed on a significant portion of the federal waterfowl refuge.

49) 5 April, 1972. CE requested a copy of a list of fishes of the Kiamichi River System from Loren Hill, University of Oklahoma.

50) 24 April, 1972. FWS approved the Rattan Landing boat ramp, on condition Corps agreed not to provide any additional public use areas within the refuge.

51) 10 May, 1972. CE informed FWS that original positions of Rattan and Frazier Point public use areas were being altered and that lake surface in wildlife refuge would be zoned as "Hazardous Area--partial clearing".

52) 19 July, 1972. Intra-agency memo from Wildlife Refuges to River Basin Studies requesting that the General Plan for Hugo Lake be expedited so that lands can be placed under Refuge system administration at earliest possible date.

53) 16 August, 1972. FWS concurred with movement of Public use area on basis of improved topographic information.

54) 14 September, 1972. Corps issued draft of General Plan for Wildlife Management Area and National Wildlife Refuge for approval of FWS and ODWC.

55) 18 October, 1972. FWS requested acreages in General Plan of 16,010 acres for a National Wildlife Refuge and 4,339 acres for the Wildlife Management Area.

56) 26 October, 1972. FWS requested that Corps reconsider development and maintenance funding for 5,900 acres of wildlife management land ($12,000 for initial development and $6,600 for annual maintenance and operation).

57) 9 November, 1972. Corps replied to FWS that funding for fencing and operation and maintenance of the wildlife management area was the responsibility of the wildlife mamangement agency.

58) 4 January, 1973. Letter from M. Standefer (ODWC) to Corps concurring with General Plan, with reservations concerning the acreage and plans for the proposed National Wildlife Refuge.

59) 20 April, 1973. Deputy Director, Bureau of Sportfisheries and Wildlife, in a letter to the Corps, maintained proposal of funding for development, operation and maintenance of Game Management Area is a mitigation measure designed to offset project-caused wildlife losses and funding should therefore be supplied by the project.

60) 3 August, 1973. Letter from William White (Acting Regional Director, FWS) to Corps requesting that 5,900 acres to be administered by the State be included as a project cost (as mitigation of wildlife habitat loss).

61) 21 August, 1973. FWS sent General Plan to ODWC for signature.

62) 18 October, 1973. CE submitted Draft Environmental Impact Statement to Council on Environmental Quality.

63) 10 January, 1974. Letter from M. Standefer (ODWC) to Corps, maintaining:
    1) no justification for a 14,396 acre refuge.
    2) State could provide greater hunter opportunities than the FWS.

64) 10 January, 1974. ODWC proposed a boundary line between the Game Management Area and the National Wildlife Refuge that would reduce refuge to 8,500 acres.

65) 17 January, 1974. Interoffice memo from Buell Atkins (Corps of Engineers) stating that allocations for refuge cannot be made until wildlife agencies reach a compromise.

66) 29 January, 1974. FWS offered to relinquish Frazier and Rock Creek areas to the GMA.

67) 29 January, 1974. Letter from W. O. Nelson (FWS) to ODWC outlining the minimum area needed for an effective National Wildlife Refuge.

68) 30 January, 1974. Impoundment of Hugo Lake Completed.

69) 5 February, 1974. Corps suggested 3-way meeting concerning boundary controversy to be held March 5, 1974.

70) 1 March, 1974. Letter from Harold O'Connor (Acting Regional Director, FWS) to Corps, stating that FWS wished to pursue the matter bilaterally with the ODWC.

71) 8 July, 1974. Letter from M. Standefer (ODWC) to FWS stating that the Department of Wildlife Conservation would not concur with the draft plans for a refuge.

72) 19 July, 1974. W. O. Nelson (FWS) proposed to Corps that Route 93 be utilized as a dividing line between National Wildlife Refuge and State Game Management Area.

73) 9 August, 1974. M. Standefer (ODWC) informed the Corps of Engineers that the State required a game management area of at least 7,500 acres, of which 25% should be tillable land.

74) 27 August, 1974. Meeting of officials of ODWC and USFWS in an attempt to arbitrate differences.

75) 4 September, 1974. ODWC rejected all proposals to negotiate boundary line.

76) 2 October, 1974. Corps interoffice memo from Buell Atkins, Environmental Resources, indicating Corps neutrality in wildlife management controversy.

77) 10 October, 1974. Final Environmental Impact Statement submitted to Council on Environmental Quality.

78) 23 October, 1974. Letter from Weldon Gamel (Corps of Engineers) to ODWC, requesting proposal for management of Hugo Game Management Area.

79) 10 December, 1974. Preliminary plan for ODWC development of multiple wildlife management area submitted to Corps.

80) 16 December, 1974. ODWC disapproved of final EIS because it included the National Wildlife Refuge in letter to the Council on Environmental Quality.

81) 23 December, 1974. Review of final EIS for Hugo Lake sent from the Acting Associated Director fo the Fish and Wildlife Service to the Director of the Office of Environmental Project Review.

82) 31 December, 1974. FWS disapproved of final EIS because it did not include provisions for project funding of fencing, development, operation, and maintenance.

83) 13 January, 1975. Letter from Assistant Secretary of the Interior Reed to Speaker Carl Albert in regard to establishment of a National Wildlife Refuge at Hugo Lake.

84) 30 January, 1975. Resumption of negotiations to permit a National Wildlife Refuge.

85) 31 January, 1975. H. G. Williamson (ODWC) submitted two plans for consideration of a Hugo Waterfowl Refuge with an ODWC Management Area that would be feasible for the Department to develop.

86) 3 February, 1975. Ecological Services finished preparation of maps showing (FWS) approximate conservation pool elevations at Stage II and III, 409.5 and 416.5 feet respectively.

87) 14 February, 1975. Meeting of officials of ODWC and FWS in attempt to resolve refuge question (Representatives of Corps of Engineers were also present).

88) 11 March, 1975. Letter from W. O. Nelson (FWS) to Corps stating that the Service would reconsider the request for State management of the Hugo Refuge.

89) 24 April, 1975. ODWC submitted proposed multiple use wildlife management program to Corps of Engineers.

90) 2 May, 1975. ODWC sent proposed multiple use wildlife management program to FWS.

91) 23 May, 1975. ODWC received "right of entry" letter from CE to begin management of the Game Management Area.

92) 1 July, 1975. General Plan Agreement sent by Corps to FWS and ODWC.

93) 22 July, 1975. Change in section No. 2 of General Plan approved by FWS.

94) 9 October, 1975. General Plan for Hugo Lake approved by all agencies.

95) 7 November, 1975. GMA manager began residence near project.

96) 15 September, 1976. CE released Appendix D: Fish and Wildlife Management Plan to Design Memorandum No. 3B, Public Use Plan.

APPENDIX B

LIST OF THE FISHES OF THE KIAMICHI RIVER BASIN

Occurrence

C = Common: Abundant throughout the area, occurring at many localities.

O = Occasional: Not widespread through the area, occurring in selective localities in small numbers.

R = Rare: Highly localized, restricted to specific habitats.

Habitat

M = Mainstream

L = Lake

T = Tributary

Common Name	Scientific Name	Occurrence	Habitat
Chestnut lamprey	Ichthyomyzon castaneus	R	M.T
Brook lamprey	Ichthyomyzon gagei	R	M.T
Shovelnose sturgeon	Scaphirhynchus platorynchus	R	M,L
Paddlefish	Polyodon spathula	R	M,L
Spotted gar	Lepisosteus oculatus	C	M,L
Longnose gar	Lepisosteus osseus	O	M,L
Shortnose gar	Lepisosteus platostomus	O	M,L
Alligator gar	Lepisosteus spatula	R	M,L
American eel	Anguilla rostrata	R	M,T
Gizzard shad	Dorosoma cepedianum	O	M,L
Threadfin shad	Dorosoma pentenense	R	L
River herring	Alosa chrysochloris	R	M
Goldeye	Hiodon alosoides	R	M,L
Grass pickerel	Esox americanus	O	M
Stoneroller	Campostoma anomalum	C	T
Carp	Cyprinus carpio	O	L,M
Golden shiner	Notemigonus crysoleucas	R	L,M
Pallid shiner	Notropis amnis	R	T,M
Emerald shiner	Notropis atherinoides	R	T,M
Bigeye shiner	Notropis boops	C	T,M
Ghost shiner	Notropis buchanani	R	M
Blackspot shiner	Notropis atrocaudalis	R	T
Bluntface shiner	Notropis camurus	R	T
Pubnose shiner	Notropis emiliae	O	T
Ribbon shiner	Notropis fumeus	C	T,M
Red shiner	Notropis lutrensis	R	T
Kiamichi shiner	Notropis ortenburgeri	C	T
Duskystripe shiner	Notropis pilsbryi	R	T
Sand shiner	Notropis stramineus	R	T
Redfin shiner	Notropis unbratilis	C	T
Blacktail shiner	Notropis venustus	O	T
Minic shiner	Notropis volucellus	C	M
Steelcolor shiner	Notropis shipplei	O	T

Common Name	Scientific Name	Occurrence	Habitat
Ozark minnow	Dionda nubila	R	T
Suckermouth minnow	Phenocobius mirabilis	R	T
Bluntnose minnow	Pimephales notatus	O	T
Bullhead minnow	Pimephales virilax	O	T
Redbelly dace	Phoxinus erthrogaster	R	T
Creek chub	Semotilus atromaculatus	R	T
River carpsucker	Carpiodes carpio	O	M
Creek chubsucker	Erimyzon oblongus	R	M,T
Spotted sucker	Minytrema melanops	O	M
River redhorse	Moxostoma carinatum	O	M,T
Golden redhorse	Moxostoma erythrurum	O	M,T
Smallmouth buffalo	Ictiobus bubalus	O	M,L
Black buffalo	Ictiobus niger	O	M,L
Largemouth buffalo	Ictiobus cyprinellus	R	M,L
Blue catfish	Ictalurus furcatus	R	M,L
Black bullhead	Ictalurus melas	O	M,T
Yellow bullhead	Ictalurus natalis	O	M,T
Channel catfish	Ictalurus punctatus	O	M
Flathead catfish	Pylodictis olivaris	O	M,L
Tadpole madtom	Noturus gyrinus	O	T
Freckled madtom	Noturus nocturnus	O	T
Priate perch	Aphredoderus sayanus	R	L
Blackstripe top minnow	Fundulus notatus	O	T
Blackspotted top minnow	Fundulus olivaceus	R	T
Mosquitofish	Cambusia affinis	O	T,M,L
Brook silversides	Labidesthes sicculus	C	T,M,L
White bass	Morone crysops	O	M
Banded pygmy sunfish	Elassoma zonatum	R	L
Green sunfish	Lepomis cyanellus	C	T,L
Warmouth	Lepomis gulosus	O	T,L
Orangespotted sunfish	Lepomis humilis	R	T
Bluegill	Lepomis macrochirus	C	L,T
Longear sunfish	Lepomis megalotis	C	T,L
Redear sunfish	Lepomis microlophus	O	L,T
Smallmouth bass	Micropterus dolomieui	R	T
Spotted bass	Micropterus punctulatus	O	T,L
Largemouth bass	Micropterus salmoides	O	L,T
White crappie	Pomoxis annularis	O	L,M,T
Black crappie	Pomoxis nigromaculatus	R	L,T
Slough darter	Etheostoma gracile	R	T,L
Goldstripe darter	Etheostoma parvipinne	R	T
Bluntnose darter	Etheostoma chlorosomum	O	T,L
Orangethroat darter	Etheostoma spectabile	C	T
Redfin darter	Etheostoma whipplei	O	T
Logperch	Percina caprodes	O	T,M
Channel darter	Percina copelandi	O	T
Dusky darter	Percina sciera	O	T
Slenderhead darter	Percina phoxocephala	O	T
Freshwater drum	Aplodinotus grunniens	O	L,M

APPENDIX C

STOCKING RECORDS FOR HUGO LAKE

DATE	SPECIES	NUMBER	WEIGHT (kg)
Apr 11, 1973	Largemouth Bass	74,500	676.5
Apr 12, 1973	Channel Catfish	44,000	399.5
Apr 13, 1973	Channel Catfish	109,600	488.1
May 1, 1973	Largemouth Bass	250,315	89.9
Oct 24, 1973	Florida Largemouth Bass	750	28.4
Oct 25, 1973	Channel Catfish	160,000	635.6
Oct 26, 1973	Channel Catfish	70,000	317.8
Oct 30, 1973	Channel Catfish	26,775	486.2
Oct 31, 1973	Channel Catfish	9,427	414.5
Nov 1, 1973	Channel Catfish	153,900	720.0
Apr 3, 1974	Walleye	1,542,139	
Apr 26, 1974	Threadfin Shad	12,000	
May 1, 1974	Largemouth Bass	412,500	124.9
May 24, 1974	Florida Largemouth Bass	10,000	
Apr 17, 1975	Walleye	1,500,000	
July 24, 1975	Hybrid Largemouth Bass	30,000	
May 21, 1976	Florida Largemouth Bass	15,000	

DATE	SPECIES	NUMBER	WEIGHT (kg)
March 28, 1977	Walleye	1,520,000	
June 3, 1977	Florida Largemouth Bass	30,000	
Oct 13, 1977	Blue Catfish	5,500	

APPENDIX D

SUMMARY OF CREEL CENSUS ON HUGO LAKE AND STILLING BASIN BETWEEN 1 JULY 1974 AND 30 JUNE 1975

HUGO LAKE

Total fishermen interviewed	224
Total fishermen hours interviewed	749.25
% successful fishermen	67.9
Average hours fished for completed trips	4.09
Catch rate (no./hour)	1.77 ± 0.178
Catch rate (kg./hour)	0.51 ± 0.070
Fisherman hours	119322.72 ± 29744.92
Fisherman hours/hectare	22.25 ± 5.55
Harvest (no)	211201.21 ± 21263.06
Harvest (kg)	61160.60 ± 8395.89
Harvest/hectare (no)	39.39 ± 3.97
Harvest/hectare (kg)	11.41 ± 1.57

HARVEST OF SPECIES

Species	No.	kg
White bass	24103 ± 8566	12232 ± 6037
Blue catfish	835 ± 765	1732 ± 1537
Channel catfish	8114 ± 2448	1732 ± 1596
Flathead catfish	955 ± 459	1191 ± 694
Bullhead	4296 ± 1989	974 ± 416
Crappie	126721 ± 19427	25926 ± 5620
Bluefill sunfish	4296 ± 1989	379 ± 278
Largemouth bass	36274 ± 6884	14505 ± 3192
Spotted bass	2506 ± 1223	866 ± 416
Carp	597 ± 612	433 ± 278
Drum	1790 ± 1836	325 ± 347
Other	835 ± 459	541 ± 347

HUGO STILLING BASIN

Total Fishermen interviewed	191
Total fishermen hours interviewed	60.2
% successful fishermen	437.50
Average hours fished for completed trips	2.14
Catch rate (no./hour)	1.37 ± 0.159
Catch rate (kg/hour)	0.29 ± 0.081
Fisherman hours	47095.2 ± 7049.31
Fisherman hours/hectare	not available
Harvest (no)	64520.42 ± 7486.62
Harvest (kg)	13458.21 ± 3834.09
Harvest/hectare (no)	not available
Harvest/hectare (kg)	not available

HARVEST OF SPECIES

Species	No.	kg
White bass	5275 ± 1328	876 ± 246
Blue catfish	754 ± 302	470 ± 246
Channel catfish	7206 ± 1872	2222 ± 959
Bullhead	3108 ± 1147	748 ± 329
Crappie	38854 ± 7124	5234 ± 1095
Bluegill sunfish	2166 ± 966	150 ± 55
Largemouth bass	235 ± 121	21 ± 27
Carp	518 ± 302	342 ± 192
Drum	5699 ± 3321	2713 ± 1862
Gar	330 ± 242	107 ± 82
Other	94	192 ± 192

APPENDIX E

WATER LEVELS AT HUGO LAKE (1974-1977)

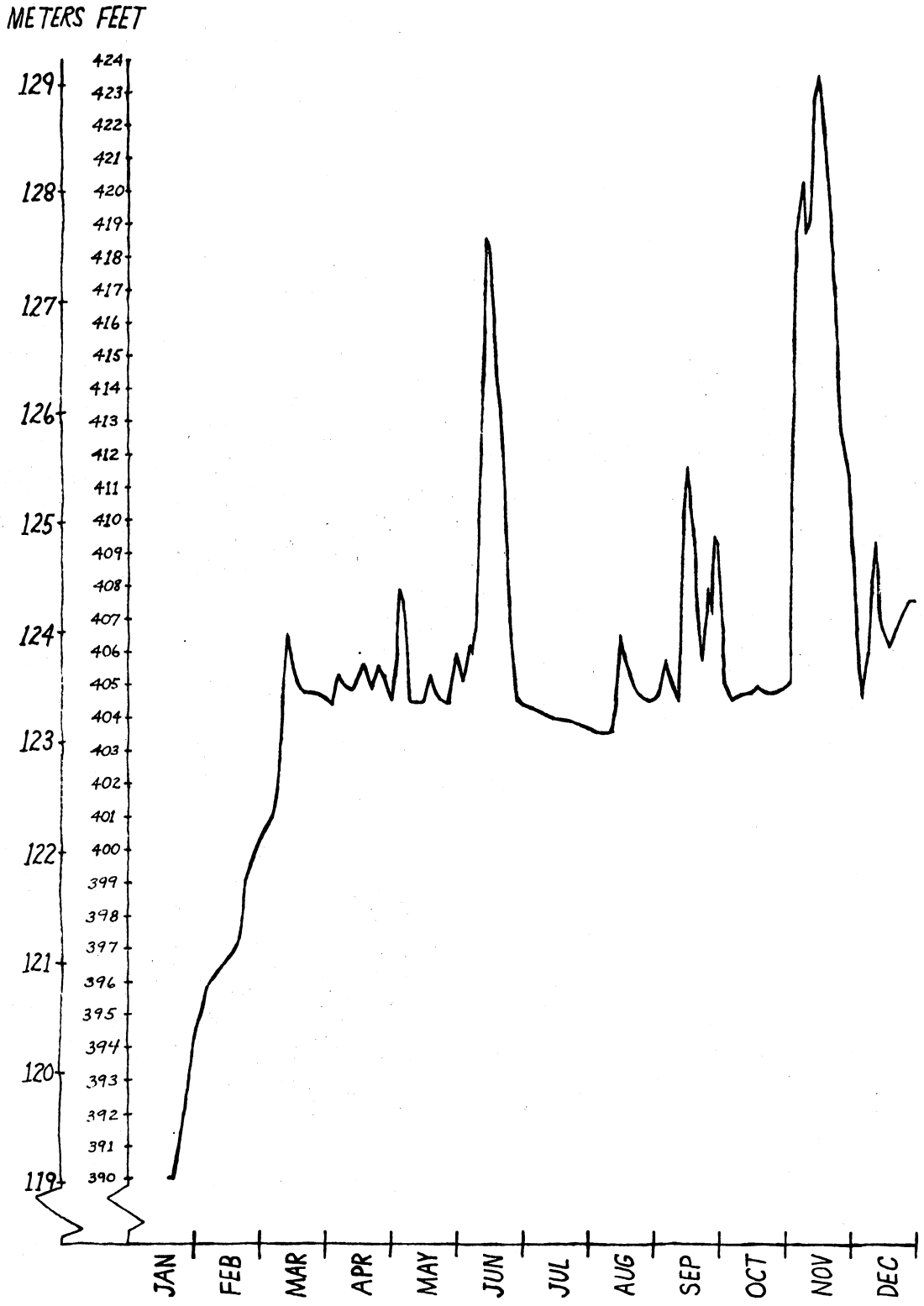

Figure 2. Water level above mean sea level, 1974

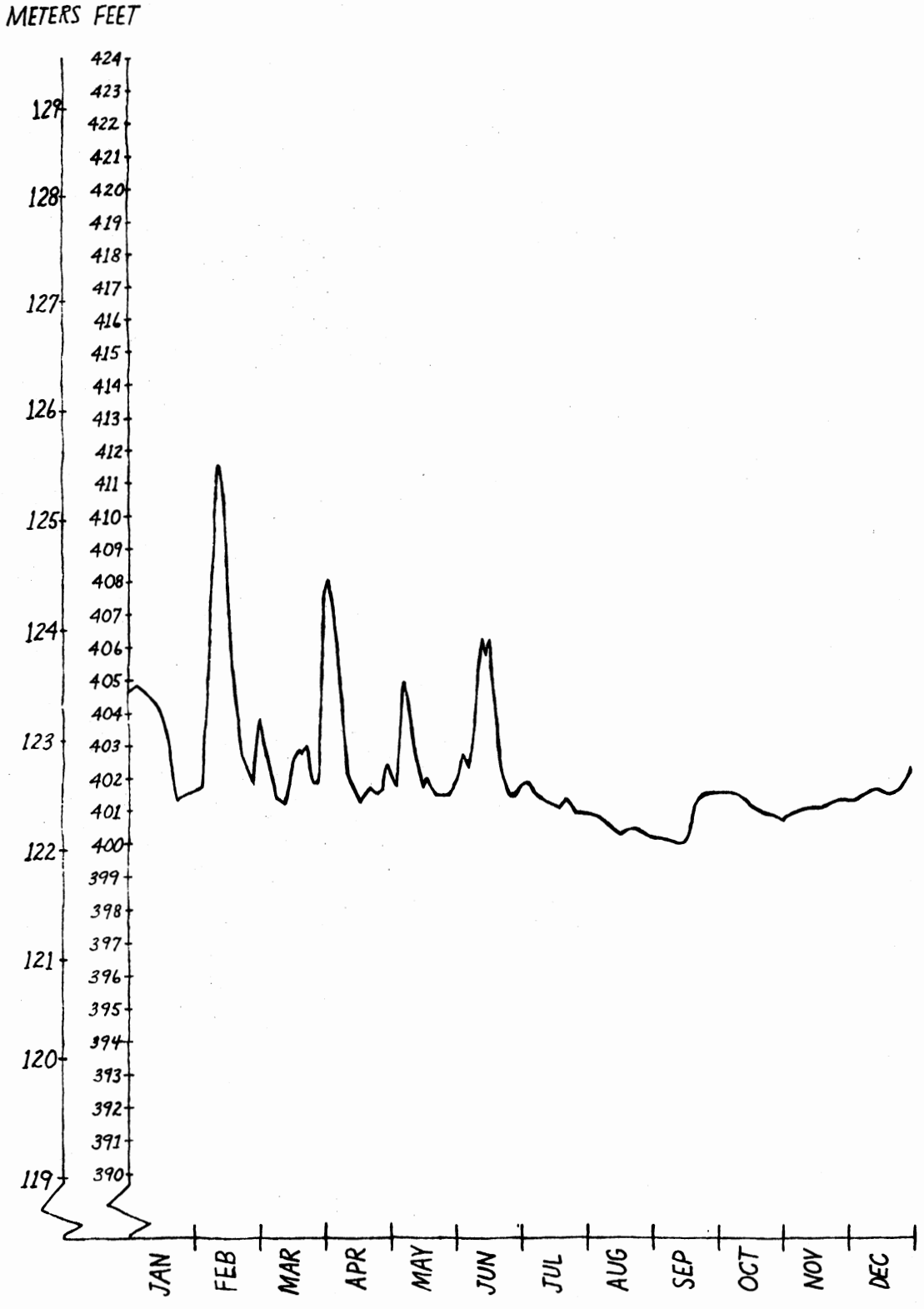

Figure 3. Water level above mean sea level, 1975

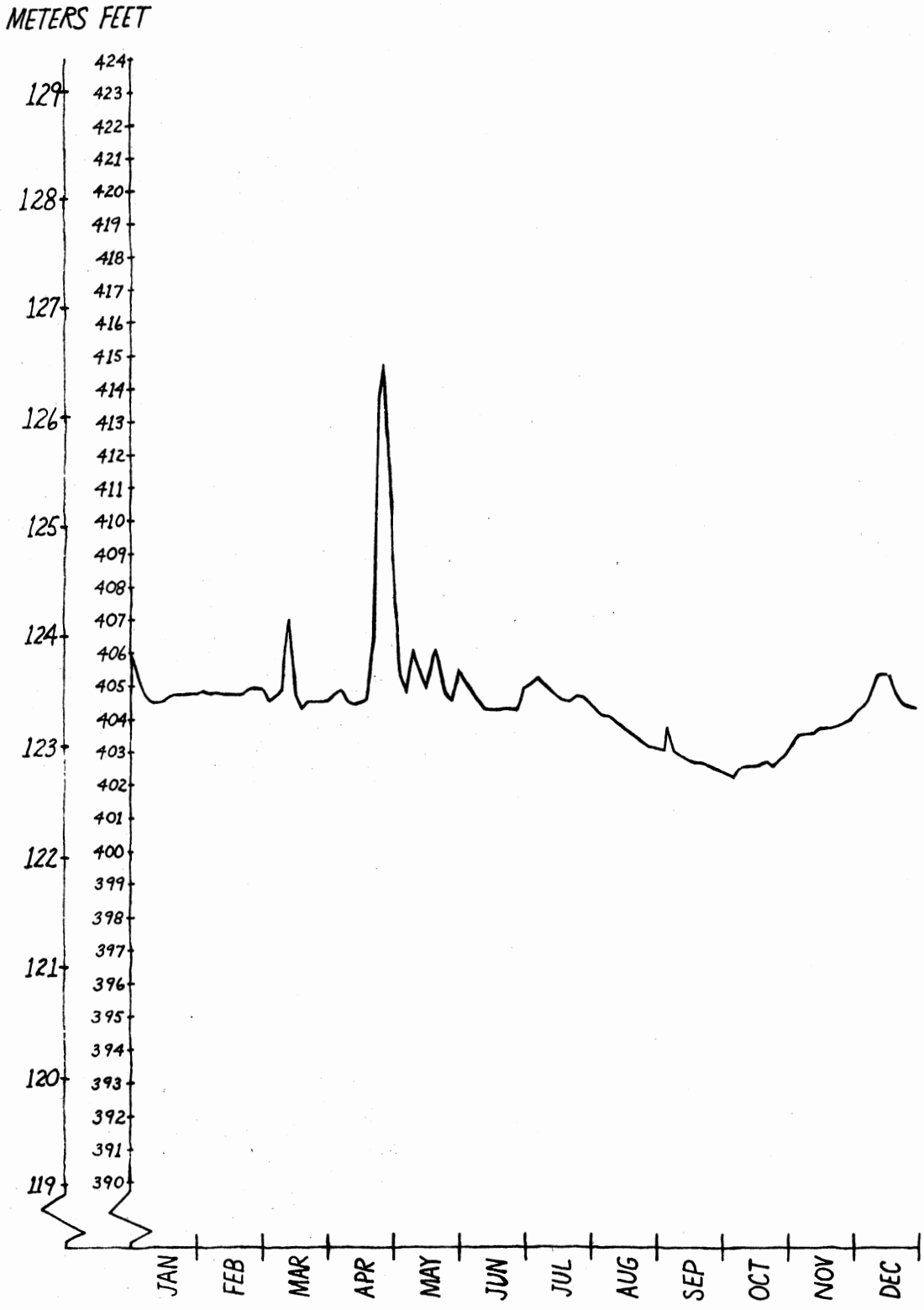

Figure 4. Water level above mean sea level, 1976

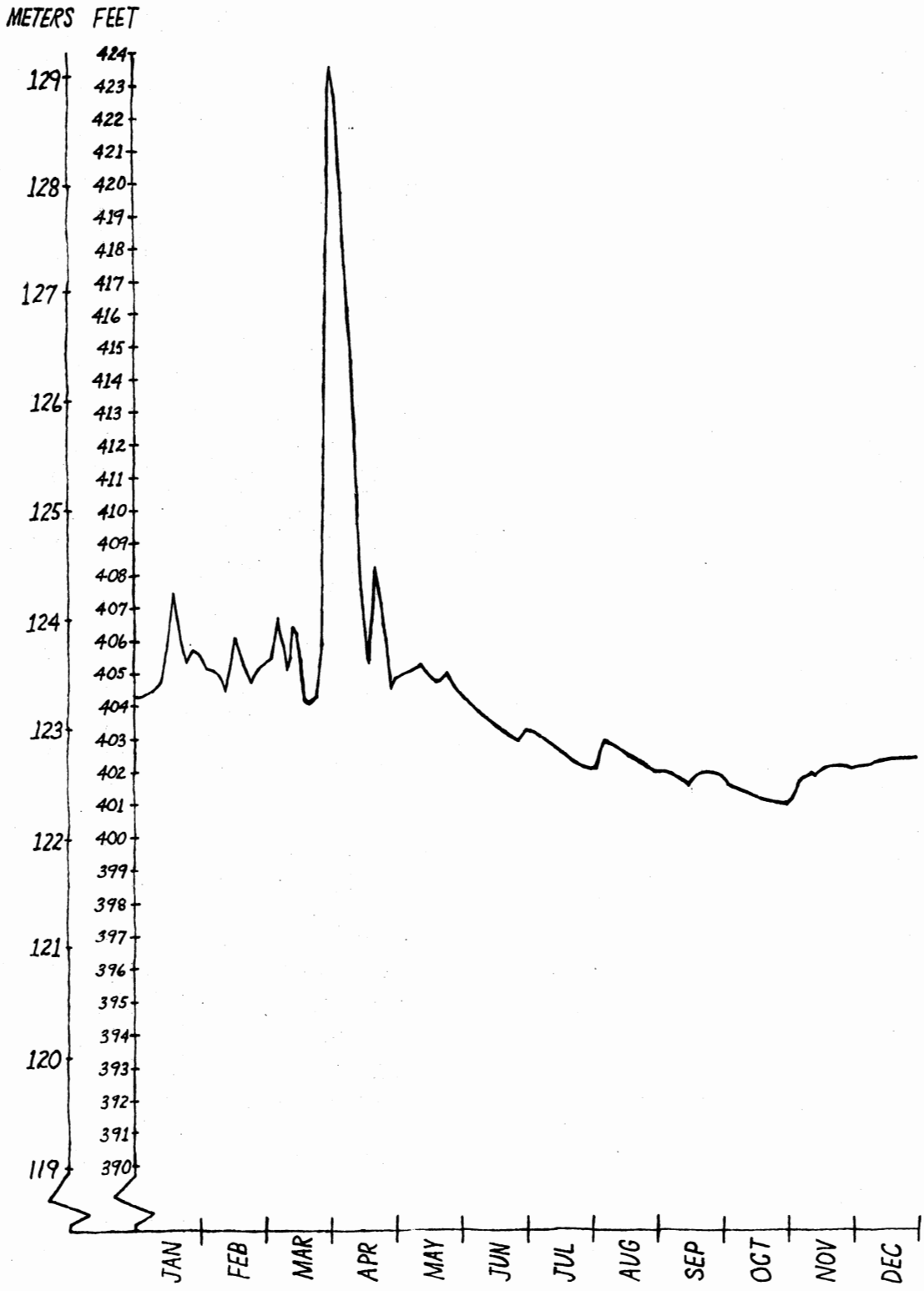

Figure 5. Water level above mean sea level, 1977

APPENDIX F

EXTREME RELEASES BELOW HUGO DAM

DURING 1974-1977

LOW FLOWS

ZERO FLOWS

8 June - 9 June 1974

1 November - 4 November 1974

10 November - 12 November 1974

8 January 1975

12 May 1975

10 June 1975 - 12 June 1975

27 March 1977 - 30 March 1977

15 Cubic Feet per Second

1 December 1976

2 December 1977

HIGH FLOWS (exceeding 10,000 cubic feet per second)

Cubic Feet per Second	Date
19,300	22 November 1974
18,200	10 June 1974
18,700	25 September 1974
18,400	15 November 1974
18,690	19 November 1974
15,500	10 March 1976
16,000	21 April 1976
18,800	5 April 1977

VITA 2

Gerald Bruce Waterfield

Candidate for the Degree of

Master of Science

Thesis: ADEQUACY OF FISH AND WILDLIFE PLANNING FOR HUGO LAKE IN SOUTHEASTERN OKLAHOMA

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