APPENDIX B

FISH AND WILDLIFE COORDINATION ACT REPORT

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

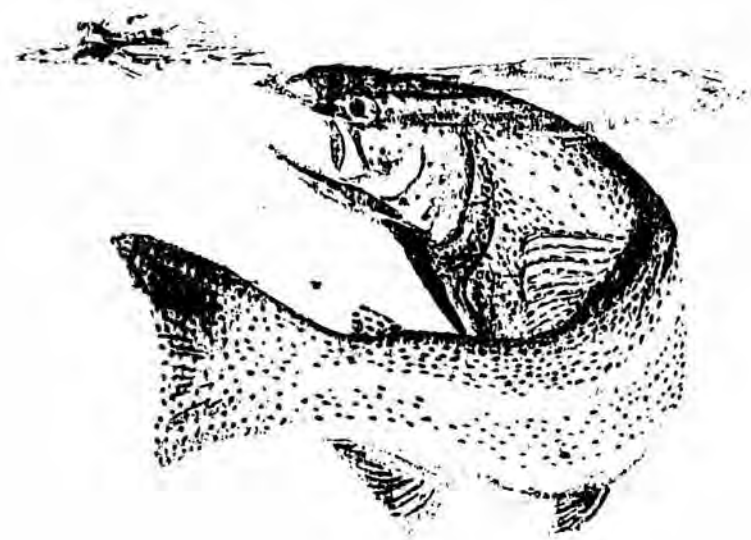
Fish and Wildlife Coordination Act Report

for the

Jackson Hole Snake River

Flood Protection/Levee Maintenance Project

Teton County, Wyoming



Prepared by

Wyoming State Office

Fish and Wildlife Enhancement

Region 6

April 1990

EXECUTIVE SUMMARY

This is the U. S. Fish and wildlife Service (Service), Fish and Wildlife Coordination Act Report on the Jackson Hole Snake River Wyoming, Levee Protection Project. Authority for this project was provided by the 1986 Water Resources Development Act (Public Law 99-662-Sec.840, Nov. 17, 1986), which authorized the Secretary of the Army to assume the operation and maintenance of the Federal and non-Federal levee system in the Jackson Hole Valley.

Our report has been prepared under the authority of the Fish and Wildlife Coordination Nation Act (48 stat. 401, as amended; 16 USC 661 et. seq.) and has the concurrence of the Wyoming Game and Fish Department (Department) as stated in their letter dated April 9, 1990 (Appendix 1). This report may need to be supplemented subsequent to the completion of the general investigation currently being conducted by the Corps of Engineers (Corps).

The flood protection/levee maintenance project involves a levee maintenance program of both Federal and non-Federal levees along the Snake and Gros Ventre Rivers in the Jackson Hole area, development of a quarry for riprap material, and periodic debris removal from the river channels. Two alternatives proposals are being examined. These are:

1. Alternative A (No Action) - no levees will be federally maintained, although the Corps would continue to provide emergency assistance in annual flood fights. It is assumed that other organizations, specifically Teton County, would retain the responsibility of maintaining the levee system. In the future, Teton County could request assistance from the Corps under Public Law 84-99 for flood fighting or levee rehabilitation.

2. Alternative B (Preferred Alternative) - the Corps would assume annual operation and maintenance of the entire levee system. Additionally, since existing rock quarries used to provide rip rap materials for current levee maintenance are limited, the Corps has proposed further investigation of four potential riprap quarry sites located on national forest lands in the vicinity of Curtis Canyon, Flat Creek, Teton Pass, and Phillip's Ridge.

Within the project area (town of Moose to South Park Bridge - 24.5 miles) the Snake River has been designated a Class 1 or "blue ribbon" trout fishery by the Wyoming Game and Fish Department (WGFD) supporting a sport fishery composed primarily of Snake River cutthroat trout and mountain whitefish. Area spring creek tributaries provide crucial spawning habitat for the cutthroat trout, since little or no spawning habitat exists in the main river. Non-game fish populations are composed almost exclusively of Utah suckers and Bonneville reside shiners.

Over 150 different species of birds have been observed within and adjacent to the project area. Of these, 119 are documented breeders. Of the total number of bird species identified, approximately 75 percent are considered passerine or songbirds. A variety of raptors utilize the project area and are either seasonal or yearlong residents. All are documented breeders within the area. Particularly important raptors which depend heavily on the riverine system include the osprey and the endangered bald eagle and peregrine falcon.

Resident and migratory waterfowl and shorebirds use the Snake River and its tributaries for spring/fall staging, breeding, nesting, brood rearing, and wintering habitat. Dabbler and diving ducks are common, along with Canada geese which utilize the Snake River and its tributaries for breeding, nesting, brood rearing, and winter habitat.

The project area also provides crucial winter habitat for trumpeter swans, primarily from Wilson Bridge downstream. Annually, 7-14 breeding pairs of trumpeter swans ar their young relied on South Park, Fish Creek, and lower Flat Creek.

An estimated 4 to 8 breeding pairs of greater Sandhill Cranes nest and rear broods each year in the project area. Annually, 30-100 sandhill cranes use the meadows between the Department South Park Habitat Unit and Spring Creek as a spring migration stopover.

A great blue heron rookery of about 150 pairs (the largest in the State) is located within the South Park area.

The Jackson Hole area supports one of the largest elk populations in North America with up to 10,000 animals wintering on the nearby National Elk Refuge and smaller numbers wintering on WGFD's 1200 acre South Park Habitat Unit, 6 miles south of Jackson.

Between 200-300 Shiras moose inhabit the valley throughout the year. During winter an additional 400-500 moose migrate from Yellowstone and Grand Teton National Parks and surrounding National Forest lands adjacent to the riverbottoms.

Most of the mule deer use in the project area occurs from late spring through fall with up to 100 animals wintering on the South Park Habitat Unit referenced above. Small numbers of white-tailed deer have also been observed interspersed throughout the Snake River drainage.

Smaller numbers of pronghorn antelope use the floodplain and sagebrush benches of the Upper Snake River during the summer and winter in the desert regions in the Green River Basin to the south.

The two quarry sites proposed for development are located east of the National Elk Refuge and are within crucial bighorn sheep winter range. Approximately 40-50 sheep winter in the proposed Curtis Canyon quarry area, with another 50 sheep wintering in the proposed Flat Creek Talus quarry site and adjacent areas.

Endangered species occurring within the project area are the whooping crane, peregrine falcon, bald eagle and the grizzly bear. The grizzly bear and bald eagle are considered residents. Given the close proximity of the Yellowstone Grizzly Bear Ecosystem it is possible that grizzlies may occur in the project area, although no recently documented sightings or observations have been reported. The project area lies approximately 2 miles outside of the grizzly bear recovery zone.

The project area contains 6 active bald eagle nesting territories, of which 5 pairs nest in the immediate vicinity of levees. Eagle nest sites are strongly oriented toward areas of the river that are not tightly restricted by levees or are associated with spring creek tributaries.

Peregrine falcon and whooping cranes are present during spring, summer, and fall. Peregrine falcon reintroduction efforts were initiated in the Jackson area in 1980 by the Peregrine Fund Inc. and State and Federal agencies. Two of the release sites are located near the project area (northwest of Wilson and on the National Elk Refuge). The nearest known peregrine nest occurs in Grand Teton National Park.

Whooping cranes from the Gray's Lake experimental population have been observed during the spring months in the riverbottom areas along the Snake River and adjacent spring creeks. In 1987, a yearling whooping crane summered in the project area near the headwaters of Spring Creek south of the Wilson Bridge. In 1988, a whooper crane summered north of the project near Moose.

The Snake River has historically been a very dynamic system which has been significantly altered in recent years through man-made changes caused by the construction of levees, dams, and irrigation diversions.

The existing levee system has had significant affects on the area's fish and wildlife resources. Long-term maintenance of the levee system would perpetuate these impacts through the ongoing deterioration of riparian, wetland, spring creek and main channel habitat. The riparian zone behind the levees will progressively change to a drier vegetative community with significant effects on the area's wildlife, particularly those dependent on riparian zones such as moose, passerine birds, great blue herons, and bald eagles and other raptors.

The current annual erosion of forested islands and cottonwood stands within the river channel will continue, possibly at a more accelerated rate. The result of this habitat loss will be a major reduction in the diversity of the Snake River floodplain ecosystem. This loss would be very significant to in-channel habitat for cutthroat trout, riverine habitat for bald eagles, and essential habitat for furbearers like otter, mink, and beaver. Additional impacts would also occur to populations of cutthroat trout with the removal of fallen trees and other woody debris during annual operation and maintenance activities.

With the elimination of major channel movement by the levee system, and in non-leveed areas by construction of channel blocks, wetlands will not be replenished and many of the oxbow and side channel wetlands will eventually be lost due to siltation. This will have an overall negative effect on area waterfowl and furbearers.

Areas below the levee sections and stretches of the river within the project area that are not significantly controlled by levees; e.g., the South Park area and in the vicinity of the Gros Ventre River, will continue to be impacted as the river dissipates its energy and drops its bedload within these reaches. The perpetuation of unstable conditions that exist in these less restrictive levee reaches will significantly affect some of the most important fish and wildlife habitat within the Jackson Hole Valley. These areas are extremely important habitats for nesting bald eagle and geese, spawning cutthroat trout, and wintering big game.

The lost capacity for flood flows to flush sediments from spawning grounds in spring creeks would continue to cause a steady decline in the suitability of spawning areas for cutthroat trout as well as the reduced capability of fish to reach these areas. Critical spawning habitat for these fishes would eventually be lost or have to be artificially maintained in order to sustain a natural spawning population of Snake River cutthroat trout.

With improved flood control there will be a corresponding increase in residential, commercial, and recreational development of the floodplain behind the levees. This has, and will continue to have, a significant cumulative secondary impact to fish and wildlife, especially in the areas near spring creek tributaries.

The aquatic and wetland/riparian habitats affected by the project are of high value and becoming scarce on a national basis. The mitigation goal is no net loss of in-kind habitat value. Therefore the Service will recommend ways to avoid or minimize losses.

Since the existing levee project has resulted in considerable habitat losses to fish and wildlife resources we believe it essential that the proposed maintenance project include provisions to maintain and restore to the greatest extent possible, the long-term productivity of this ecosystem. The Water Resources Development Act of 1986 (Water Bill) provided important provisions that could help to accomplish this end; these being Sections 906(b) and 1135.

Section 906(b) provides authorization for mitigation features to mitigate damages to fish and wildlife resulting from any water resource project under the Secretary of the Army's jurisdiction, whether completed, under construction, or to be constructed.

Section 1135, which has recently been extended for another three years by Congress, authorized the review of projects constructed before enactment of the Water Bill to assess the need to modify structures and operations of water resource projects for the purpose of improving the quality of the environment.

We strongly advocate that these two provisions be pursued by all involved entities to fund the development and implementation of a plan to restore and maintain this ecosystem of national importance. The plan must recognize that the restoration of this ecosystem should be viewed as a long-term mitigation plan and that the degree of success will depend on the extent to which natural channel and floodplain features are re-established and maintained. This approach needs to emphasize good cooperative relationships with floodplain landowners. Therefore, we recommend that, under the Corps and Service leadership, a task force represented by landowners, natural resource groups, and local, State, and Federal agencies be established to develop a cooperative management plan to be implemented for the Jackson Valley of the Snake River. To facilitate the development of the plan, a variety of environmental and hydrological studies and surveys needs to be conducted, which are detailed on page 72 of the attached Coordination Act Report.

In the interim, until a comprehensive management plan is developed and funded, it is recommended that conservation measures be implemented to minimize future impacts of fish and wildlife resources by the project. These measures, which are found on pages 74-75 of the attached Coordination Act Report need to be specifically formulated and incorporated into the O&M plan and decision documents for the levee project.

In summary, the proposed project will result in significant adverse impacts to important fish and wildlife resources of the Upper Snake River Basin. Therefore the Service will not support implementation of the project unless the foregoing studies, comprehensive planning, and mitigation measures are included as an integral part of the proposed plan.

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INTRODUCTION

This constitutes the U.S. Fish and Wildlife Service (Service) report for the Jackson Hole Snake River Wyoming, Flood Protection Project and was prepared under authority of the Fish and Wildlife Coordination Act (48 Stat. 401 as amended; 16 U.S.C. 661 et. seq.). This report was prepared in cooperation with, and has the concurrence of, the Wyoming Game and Fish Department (Department) [see attached letter dated April 9, 1990 in Appendix 1].

This report is not intended to satisfy the requirements of Section 7(c) of the Endangered Species Act, as amended. It contains a description of endangered species that may occur in the project, discussion of possible impacts on these species, and recommended protection and/or conservation measures to reduce these impacts.

The flood protection/levee maintenance project involves a levee maintenance program of both Federal and non-Federal levees along the Snake and Gros Ventre Rivers in the Jackson Hole area, development of a quarry for riprap material, and periodic debris removal from the river channels. This project is authorized by Public Law 99-662, Water Resources Development Act of 1986.

The Coordination Act Report relies heavily on existing information from other Federal, State, and local agencies as well as existing scientific literature. Within the project area the Service has prepared two preliminary aid reports (biological evaluations in June of 1987 and November of 1988) for the U.S. Army Corps of Engineers (Corps) that were used extensively in the preparation of this document. Two project alternatives, as proposed by the Corps, were evaluated and analyzed to determine affects of the proposed actions on area fish and wildlife resources. This report provides an analysis of the impacts on fish and wildlife resources from the flood protection measures recommended by the Corps for the project area. Recommendations to mitigate adverse impacts on those resources are also presented. This document will constitute the report of the Secretary of the Interior as required by Section 2(b) of the Fish and Wildlife Coordination Act.

DESCRIPTION OF STUDY AREA

Approximately 97 percent of the land in Teton County is in public ownership, predominately national forest (Bridger-Teton and Targhee), national park (Teton), refuge system (National Elk Refuge) or state holdings. In addition, Jackson Lake and the Snake River provide diverse recreational opportunities. About 4 million people annually visit national parks and national forest lands in the area (Twiss et al. 1976).

Tourism is the major industry of the area providing a significant monetary increase to the local economy of Teton County throughout the year. Due to the extreme seasonal nature of employment in the County, it is difficult to project the number of year-round jobs. Currently, the Teton County Planning Department has estimated employment to be at approximately 11,000. Of that total, 88 percent are in trade and service categories that are heavily dependent on tourism (Bradley 1989, pers. comm.). The remaining employment is fairly evenly distributed throughout the other industrial sectors.

The current 1989 population estimate for Teton County is 13,650, compared to a population census in 1970 of 4,880, an increase of 8,770 or 179 percent. The rate of population growth has fluctuated from 4.3 percent in the 1960's, to 7.3 percent in the 1970's, and 2.4 percent in the 1980's. At a 5 percent growth rate, the County's 1999 population is projected to be about 22,236. Most of the projected population increase is attributed to anticipated growth in the recreational sector and the number of people moving to Teton County for retirement (Bradley 1989, pers. comm.).

Short, mild summers and long, cold winters characterize the climate of Jackson Hole. The mean annual temperature is about 35 degrees fahrenheit (°F) and frost may occur during any month. Winter temperatures can drop to -40°F. Precipitation varies widely within the area due to elevation differences and the rain shadow effect of the Teton Mountains. Annual precipitation averages 27 inches (ranging from 15 to 30 inches) in Jackson Hole and may exceed 60 inches in the surrounding highlands. About 75 percent of the precipitation falls as snow from November-April.

The Teton Range dominates the Jackson Hole area with The Grand Teton rising to 13,770 feet. The valley floor is approximately 6,500 feet above sea level. The Tetons are a fault-block mountain range. The crust of the earth fractured along a line and uplifted to form the Tetons. Jackson Hole is part of the adjacent crustal block, which is still tilting downward along its western edge at the base of the Teton Range.

The valley area has undergone various stages of volcanism, glaciation and uplifting. Ice invasion formed the entire Snake River channel and surrounding lowlands in the valley during three distinct glacial periods. Geologic features of the valley include glacial outwash plains and moraines, isolated buttes, river terraces and floodplains. Jackson Lake was formed about ten thousand years ago when glacial moraines blocked the southward flow of the Snake River and diverted it eastward. The major rivers and their tributaries (Figure 1) have cut braided channels through the glacial outwash plains (Kroger 1967, Houston 1968).

The Snake River starts in highlands of the Teton Wilderness Area and Yellowstone National Park and flows southward to Palisades Reservoir near the Wyoming-Idaho border. The river drains over 3,465 square miles of watershed along the western Continental Divide in northwestern Wyoming. The drainage includes the Teton and Salt River Ranges and portions of the western slope of the Wind River Range. The river flows southwesterly from Yellowstone National Park for 40 miles before flowing into Jackson Lake in Grand Teton National Park. From the lake, the river flows southerly for about 48 miles through Jackson Hole Valley where it is bordered by Grand Teton National Park, Bridger-Teton National Forest and private lands. Downstream of Jackson

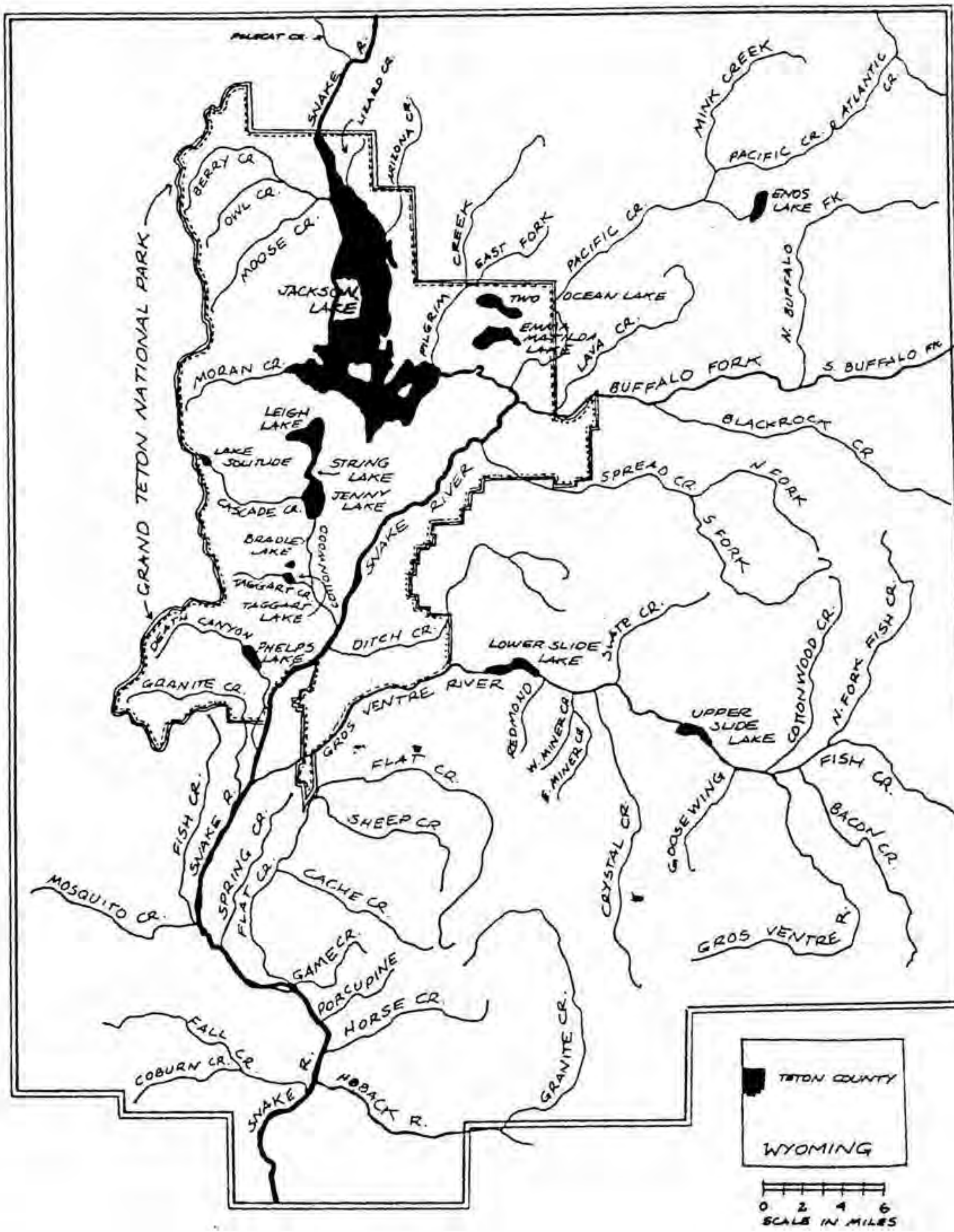


Figure 1. Major rivers, streams, and lakes in Jackson Hole (from Clark 1981).

Hole the river flows for 32 miles through a steep-walled canyon before entering into Palisades Reservoir. The principal tributaries to the Snake River within the influence of the project area include the Gros Ventre River, Fish and Flat Creeks.

The Snake River, within the Jackson Hole area, cuts across mountains which are resistent to erosion. This establishes a base level which retards downcutting in the basin and results in lateral erosion (Fryxell 1980). Lateral erosion accounts for braiding of segments of the river in the southern region of Jackson Hole and in the project area. Braided streams are composed of a complex system of converging and diverging channels which are separated by sand bars and islands. Under pristine conditions the river channel gradually shifted its course across the floodplain seeking a course of least resistance. In recent years, however, the dynamics of the river have been interrupted because of man-made alterations (i.e., levees, dams, irrigation diversions, etc.). Of these alterations, the levee system has had the most pronounced affect. The levees act to restrict lateral river channel migration, thereby reducing the flooding zone within which the channels migrate from 5,000 to 8,000 feet down to 1,000 to 2,000 feet.

During the period between 1975 and 1987, the average river discharge through the project area was 3,785 cubic feet per second (cfs) (U.S. Geological Survey, Snake River below Flat Creek gauging station). A maximum discharge of 25,600 cfs occurred on June 6, 1986 and a minimum discharge of 780 cfs occurred on December 31, 1978. The annual flow pattern in the project area has been significantly modified by storage and release of water for irrigation by Jackson Lake Dam. This has resulted in reduced river flows from October to May, when water is stored, and higher river flows from July to September when water is released for irrigation.

Snake River flood events in the project area result primarily from snowmelt and occur in a regular pattern of prolonged high flows in May, June, and July. Annual peak discharge at the Wilson Bridge (see Figures 2, 3 and Table 1) has been estimated from gage records of the Snake River at Moran (Wyoming), Heise (Idaho), and for tributary streams. These estimates indicate that peak flows exceeding 20,000 cfs have occurred 13 times between the years 1904 and 1986. Peak discharge greater than 10,000 cfs have occurred 74 times. The largest known discharge (estimated at 41,000 cfs) occurred in 1894 and the second largest (estimated at 32,500 cfs) occurred in 1918. Major floods (flows over 20,000 cfs) are tabulated below:

Year	Peak Flow (cfs)	Year	Peak Flow (cfs)
1894	41,000	1943	22,800
1918	32,500	1911	21,900
1904	28,500	1982	21,800
1909	25,900	1913	21,200
1986	25,600	1914	20,700
1917	23,400	1928	20,700
1927	22,900*	1912	20,200

*Peak flows from normal snowmelt.

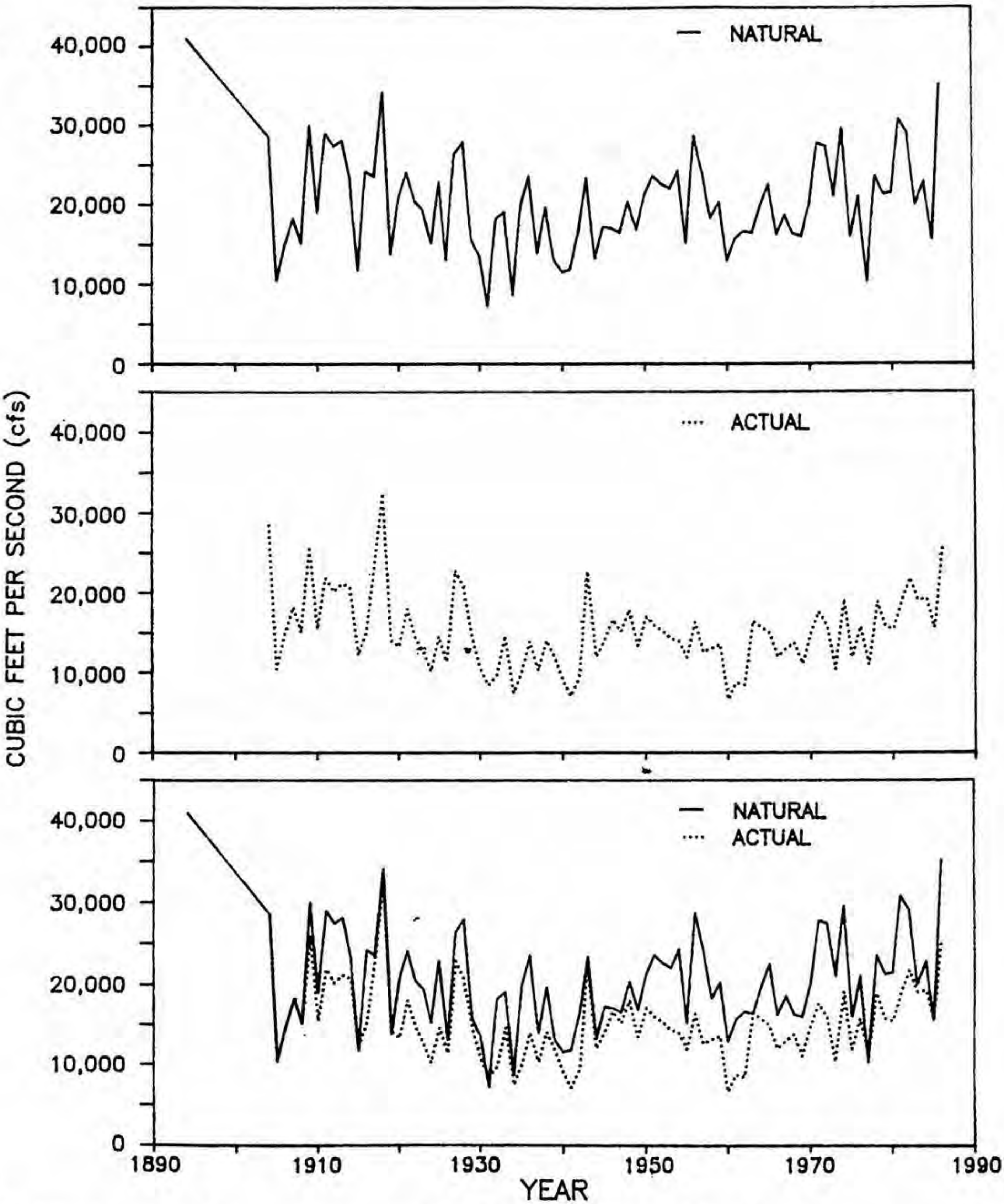


Figure 2 . Annual peak discharge in cubic feet per second for the Snake River at Wilson Bridge from 1894 to 1986.
(FROM U.S. FISH & WILDLIFE SERVICE 1988)

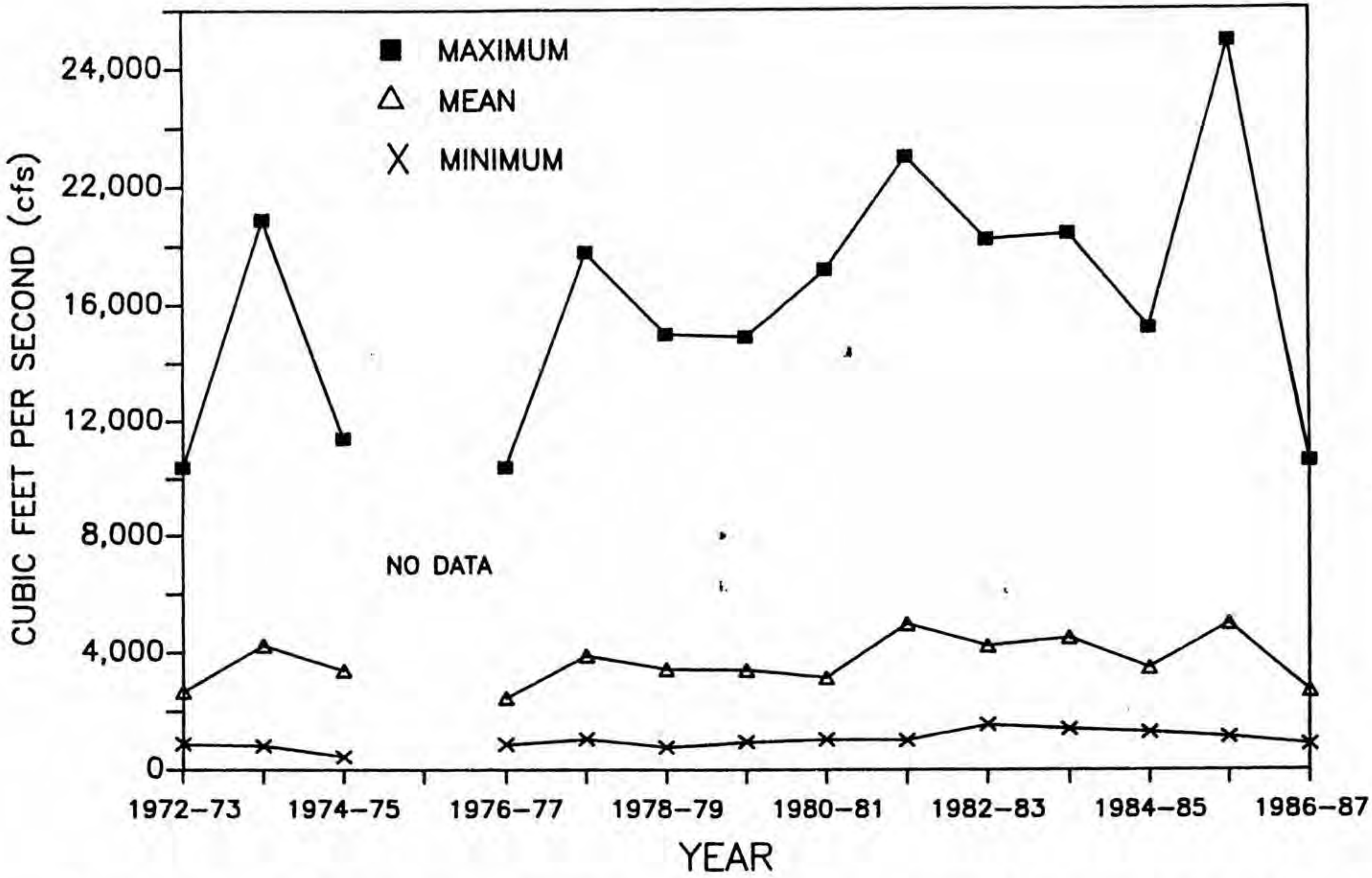


Figure 3 . Minimum, mean, and maximum water year discharge in cubic feet per second for the Snake River at Wilson Bridge from 1972 to 1987. (FROM U.S. FISH & WILDLIFE SERVICE 1988)

Table 1. Annual peak discharges of the Snake River at Wilson Bridge (D.A. = 2,500 square miles).

Water Year	Actual[a] Cfs	Actual[a] Date	Natural[b] Cfs	Natural[b] Date	Water Year	Actual[a] Cfs	Actual[a] Date	Natural[b] Cfs	Natural[b] Date
1894	0	0	41,000	0	1945	14,100	6/25	17,300	6/25
1904	28,500	5/24	28,500	5/24	1946	16,700	6/6	17,100	6/6
1905	10,400	6/8	10,400	6/8	1947	15,200	6/9	16,500	6/9
1906	14,800	6/13	14,800	6/13	1948	18,000	6/3	20,400	6/3
1907	18,300	6/21	18,300	6/21	1949	13,400	6/20	16,900	6/12
1908	15,100	6/16	15,100	6/16	1950	17,100	6/30	21,300	6/17
1909	25,900	6/18	30,000	6/18	1951	16,000	6/17-8	23,600	5/29
1910	15,500	5/11	19,000	6/2	1952	15,300	6/7	22,600	6/7
1911	21,900	6/20	29,000	6/14	1953	14,300	6/23	22,000	6/14
1912	20,200	6/24	27,400	6/8	1954	14,000	5/23	24,300	5/22
1913	21,200	6/5	28,100	5/27	1955	11,900	6/24	15,200	6/14
1914	20,700	6/5	23,300	6/3	1956	16,400	6/3-5	28,700	6/2
1915	12,200	6/27	11,700	6/1	1957	12,600	6/6	24,000	6/6
1916	15,100	6/19	24,200	6/18	1958	13,100	5/22	18,300	5/26
1917	23,400	6/17	23,500	6/17	1959	13,600	6/15-6	20,300	6/15
1918	32,500	6/14	31,200	6/14	1960	6,700	12/4	12,900	6/3
1919	14,100	6/16	13,800	5/29	1961	8,800	6/20	15,700	5/26
1920	13,300	7/26	20,900	6/9	1962	8,500	6/13	16,700	6/13
1921	18,100	6/14	24,100	6/13	1963	16,550	6/14	16,400	6/15
1922	14,500	6/22	20,400	6/7	1964	15,700	6/5	19,870	6/6
1923	12,600	8/10	19,300	5/26	1965	15,000	6/13	22,500	6/14
1924	10,200	7/19	15,200	5/19	1966	12,000	5/9	16,200	6/10
1925	14,600	6/30	22,900	5/22	1967	13,000	6/27	18,700	6/22
1926	11,400	5/23	13,000	5/21	1968	13,800	6/23	16,300	6/4
1927	22,900	6/25[c]	26,400	6/14[c]	1969	11,100	6/15	16,000	6/15
1928	20,700	5/30	27,900	5/28	1970	14,900	6/15	20,200	6/15
1929	14,600	6/17	15,600	6/15	1971	17,700	6/15	27,800	6/15
1930	10,700	6/11-2	13,500	5/30	1972	15,900	6/15	27,400	6/15
1931	8,460	7/20	7,200	5/16	1973	10,400	6/9	21,080	6/9
1932	9,800	6/25	18,300	5/22	1974	19,200	6/18	29,640	6/18
1933	14,700	6/15	19,100	6/17	1975	11,900	6/8	16,000	6/8
1934	7,500	5/8	8,600	5/7	1976	15,800	6/4	21,100	6/4
1935	10,100	6/13	20,000	6/14	1977	11,000	6/9	10,300	6/9
1936	14,000	6/1	23,600	6/1	1978	19,000	6/10	23,600	6/10
1937	10,300	6/23	13,900	5/29	1979	15,800	5/28	21,300	5/28
1938	14,100	6/18	19,700	6/7	1980	15,500	5/24	21,500	5/24
1939	11,900	5/31	13,000	5/31	1981	19,000	6/10	30,800	6/10
1940	9,150	7/14	11,500	5/26	1982	21,800	6/29	29,000	6/29
1941	7,100	7/18	11,800	5/14	1983	19,100	5/30	20,000	5/30
1942	9,500	6/25	16,600	6/9	1984	19,300	6/1	22,900	6/1
1943	22,850	6/22	23,400	6/22	1985	15,600	6/9	15,600	6/9
1944	12,000	6/2	13,200	6/27	1986	25,600	6/6	35,174	6/6

[a]Estimated from records at other locations in many years.
[b]Discharge without effect of Jackson Lake storage, which has regulated flows since 1909.
[c]Excludes effects of washout of landslide on Gros Ventre River. Peaks including effect of washout would be much larger than values shown.

In 1925, a landslide dammed the Gros Ventre River, forming a temporary lake. This dam broke in 1927, causing a peak flow in the Snake River greater than any discharge shown in this tabulation. A reliable estimate of that flood flow cannot be made.

DESCRIPTION OF PROJECT PLAN

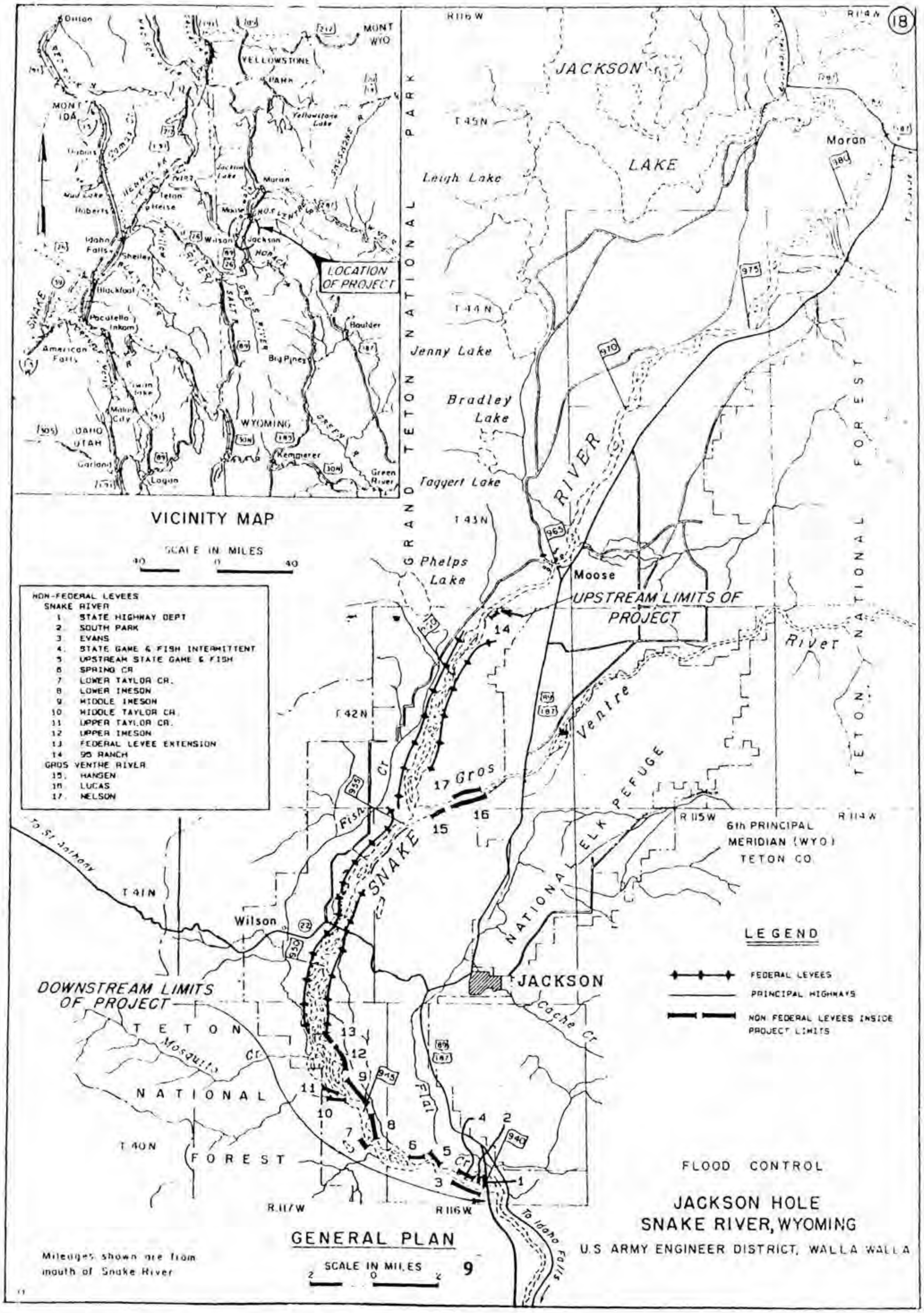
During the early 1900's large releases of water from Jackson Lake Dam created flooding conditions in the Snake River. This occurred as many as two to three times annually. As a result of these large water releases, lateral erosion along the river banks became a serious problem. The washout of Lower Slide Lake on the Gros Ventre River in 1927 may have also exacerbated flooding in the Snake River. Debris from the landslide partially filled the Snake River channel, decreasing its depth and causing flood flows to dissipate out of the channel more frequently. Local residents sought better control of releases from Jackson Dam in 1947 to reduce flooding and erosion damage. In the spring of 1950 a severe natural flood occurred in the valley and local landowners asked the Corps to provide aid in protecting their property. This request resulted in the authorization by Congress of a levee project, as authorized by the Rivers and Harbors Act of 1950 (P.L. 81-516), for the purpose of directing flows, assisting in bank stabilization, alleviating flood damage, and conserving water for irrigation purposes.

The existing Federal levees begin three miles below Moose, Wyoming and end approximately three miles below Wilson Bridge, a distance of 14.5 miles (Figure 4). Levee construction initially began in the early 1950's and has been expanded periodically through emergency maintenance repairs conducted by the Corps. Several smaller non-Federal levee projects have also been constructed by other Federal and State agencies and private citizens along the lower two miles of the Gros Ventre River and Snake River within the South Park area below Wilson. Most of the latter levees were built between 1967 and 1977 through emergency actions authorized under Public Law 84-9 (Corps 1989b). The cumulative extent of levees along both banks of the Snake River and Gros Ventre Rivers is approximately 35 miles.

The levee system within the project reach includes three Federal levee segments totaling 26.5 miles, or about 75 percent of the total levee mileage in the system. The three non-Federal levees on the lower Gros Ventre River cover a total distance of 3 miles and are located primarily along the left (south) bank. Twelve non-Federal levee segments are situated on the Snake River and tributary creeks below the Wilson Bridge, accounting for a collective distance of about 5.5 miles of levees. Most of the levee mileage in this lower area is along the left (east) bank. The other non-Federal levee, the 95 Ranch Levee, is a short levee along the left bank located upstream of the Federal levees (Corps 1989b).

The Federal levees constructed during the 1950's are not as effective at flood control as originally planned. The levees were originally designed to give protection for a 500-year flood of 45,000 cfs. In 1974 and in 1986, floods of much less magnitude damaged the levees. Presently, the Federal levees are recognized as providing 100-year flood protection (Corps 1989b).

Figure 4. The existing permanent Corps of Engineer levees and other state, county, and private levee locations along the Snake River in Jackson Hole, Wyoming.



The Upper and Middle Taylor Creek non-Federal levees provide 100-year and 50-year flood protection respectively. The remaining non-Federal levees generally provide only 10-year or annual flood protection (Corps 1989b).

The original levee design placed the levees inside natural, active flood channels adjacent to the main channel. Thus, the levees confined the river to less than its natural flood width and has resulted in constant channel changes and extensive levee maintenance. Had the levees been placed farther away from the main channel, annual flood damage to the levees would be less, and the capacity to contain greater floods would be assured (Haible 1976). Annual aggradation of gravel and sediment deposition in certain levee sections also has increased bedload materials and reduced channel capacity. This is probably a major factor contributing to the formation of new gravel bars and annual changes in river channel locations. In general, the gravel are being deposited in the center of the river causing increased water velocities in river channels next to the levees (Haible 1976).

In the past, most maintenance activities have been performed on an emergency basis to repair levees during and following spring floods. This has resulted in an increased potential for levee failure, a need for frequent repairs, and high costs associated with emergency actions. As a result of the significant maintenance requirements of the levees, the project sponsor (Teton County), through the Wyoming congressional delegation, requested the Federal government to assume annual maintenance of the levee system. This was sanctioned under the Water Resources Development Act of 1986 (P.L. 99-662, Sec. 840), which authorized the Corps to assume responsibility for operation and maintenance (O&M) of the above mentioned Federal and non-Federal levees in the Jackson Hole area. The following alternatives are being evaluated by the Corps for possible implementation under the authorization:

Alternative A (No Action): This alternative would involve the Corps taking no action in the maintenance of the levees in Jackson Hole area, however it would continue to provide emergency assistance in flood fights. Although the Corps would not be involved in maintenance activities, it is assumed that other organizations, specifically Teton County, would retain the responsibility of maintaining the levee system. In the future, Teton County could request assistance from the Corps under PL 84-99 for flood fighting or levee rehabilitation. The decision by the Corps to participate would be based on economic and environmental evaluations, as required by current regulations. Maintenance activities with this alternative would presumably continue as in the past. Current practice generally includes plowing snow from the levees during the spring, patrolling the levees to detect damage during the peak runoff period, and regrading or graveling the levee roadways and associated access roads when necessary. Teton County would operate the quarry planned to provide riprap and levee core fill. Major flood fights and emergency rehabilitation actions would be conducted by Teton County with the assistance of the Corps and possibly the State of Wyoming. These maintenance and repair activities are assumed to occur over the entire levee system, amounting to 35 linear miles of levee.

Alternative B (Preferred Alternative): This alternative would involve the Corps taking over responsibility for annual maintenance of all levees in the system. This would include all Federal and non-Federal levees on the Snake River from Grand Teton National Park to the South Park Bridge, plus three non-Federal levees located on the lower reach of the Gros Ventre River. Maintenance activities would include removing snow from the tops of the levees in early April to allow and facilitate access for patrolling and flood fights, conducting emergency repairs, rock quarrying and stockpiling operations to obtain levee materials, removing perennial vegetation (trees) from levees, removal and burning of snags that might damage the levees, and maintenance of culverts and roads providing access to the levees. Avulsion (Channel Shifts) prevention in non-Federal levee reaches of the system may require the placement of channel blocks as part of a flood fight effort. Unless engineering, economic, and environmental assessments indicate that channel block structures are viable, they will be removed. Under this alternative, it is assumed that Teton County would retain responsibility for patrolling the levees from the beginning of the high flow period (10,000 to 12,000 cubic feet per second) until the flood peak subsides to that level. Since the existing Walton quarry has limited quantity and quality of riprap, the Corps has proposed further investigation of four potential quarry sites on national forest land in the vicinity of Curtis Canyon, Flat Creek, Teton Pass, and Phillips Ridge.

FISH AND WILDLIFE RESOURCES OF PROJECT AREA (EXISTING CONDITION)

Aquatic Resources

The Snake River reach that flows through the project area is a Class 1 or "blue ribbon" trout fishery as designated by the Department. This designation signifies that the river is of national importance as a trout fishery and warrants the highest priority for protection (Kiefling 1981).

Sport Fishery

Within the project area (town of Moose to South Park Bridge - 24.5 miles) the Snake River sport fishery is composed primarily of Snake River cutthroat trout (Oncorhynchus clarki spp.); the most sought after game fish by anglers. Based on information collected in 1985, the Department estimates that the cutthroat population consists of approximately 1,200 fish per mile (about 846 pounds per mile).

Mountain whitefish (Prosopium williamsoni) are also found in large numbers within the project area, and are sought by anglers. Estimates developed from the above mentioned 1985 study revealed that the river supports about 8,400 mountain whitefish per mile (420 pounds per mile). Other game fish found in this reach of the river include brown (Salo trutta), brook (Salvelinus fontinalis), rainbow (Oncorhynchus mykiss), and lake trout (Salvelinus namaycush). (Refer to Table 2 for a complete fish species list). These populations should be considered as incidental since they are not significantly measurable populations. Reports of grayling have been received in the past; however, the only documentation of their presence is based on the capture, photograph and release of one specimen several years ago. This specimen most likely drifted downstream into the Snake River from Toppings

Table 2. Fish Species Occurring in the Jackson-Snake River Area.

Family	Common Name
Gamefish	
Salmonidae	Snake River cutthroat
	Lake trout [a]
	Brown trout
	Rainbow trout
	Brook trout
	Mountain whitefish
Nongame Fish	
Cyprinidae	Boneville Redside shiner
	Speckled dace
	Longnose dace
	Utah chub [b]
	Leatherside chub
Catostomidae	Utah sucker
	Bluehead sucker [c]
	Mountain sucker
Cottidae	Mottled sculpin
	Piute sculpin

a. Lake trout occasionally pass through the dam from Jackson Lake into the Snake River.

b. The leatherside chub is uncommon in Wyoming.

c. The bluehead sucker is abundant in the Snake River, but listed by the State of Wyoming as rare in other parts of the State.

Lake. Biologically viable populations of this fish do not occur in the river.

Snake River Fine-Spotted Cutthroat Trout: The Snake River fine-spotted cutthroat trout, an indigenous subspecies, inhabits Jackson Lake and the Snake River from its headwaters in Yellowstone National Park to Palisades Reservoir in Idaho. This subspecies is noted for its spotting pattern which is atypical of other Rocky Mountain cutthroat trout. It has selectively adapted to the rigorous riverine environments typical of the upper Snake River (Kiefling 1978, 1981, 1984; Simpson and Wallace 1982).

Spawning habitat for cutthroat trout is considered one of the major limiting factors in the upper Snake River drainage (Kiefling 1978). Little or no spawning habitat exists in the main river because high flows, particularly during spring run-off, produce large sediment bed loads and turbidity during the spawning period. Habitat losses due to human activities (i.e. diversions for irrigation and levee construction) have also contributed to the limited availability of spawning habitat. Presently, spawner recruitment is primarily limited to spring-fed tributaries (Figure 5). In an effort to improve spawning success, the Department has expended significant amounts of time and money to enhance and renovate a limited number of areas within the Three Channel Spring Creek complex. Their actions have included adding large amounts of commercially purchased gravel, creating instream log habitat structures, and implementing an eyed-egg stocking program (Kiefling 1978 and 1984; Erickson 1980).

Cutthroat trout typically enter the spring creeks in March, with spawning occurring in April and continuing into May. Fry emerge throughout late spring and early summer, spending their first year in the tributaries where they hatched. Important spring creek tributaries with the project area and estimates of existing fish spawning population densities are shown in Table 3. However, a few drift downstream to overwinter in the larger and deeper gravel habitat of the main river (Kiefling 1978).

Table 3. A summary of important spring creek tributaries within the project area and estimated fish spawning population densities. (Annear 1989b).

Name	Est. Spawning Fish	Fish/Mile
Spring Creek	458	190
Blue Crane Creek	118	160
Lower Bar BC Spring Creek	315	UNK
Little Bar BC Spring Creek	40	UNK
Three Channel Spring Creek	354	UNK
Price Spring Creek	178	UNK
Fish Creek*	UNK	UNK

* Spawning habitat improvement not conducted by Department
UNK= Unknown

Instream flow studies conducted by Department have suggested that the abundance of low-flow overwintering habitat may also be a major factor contributing to Snake River Cutthroat abundance (Annear 1989a). Lack of

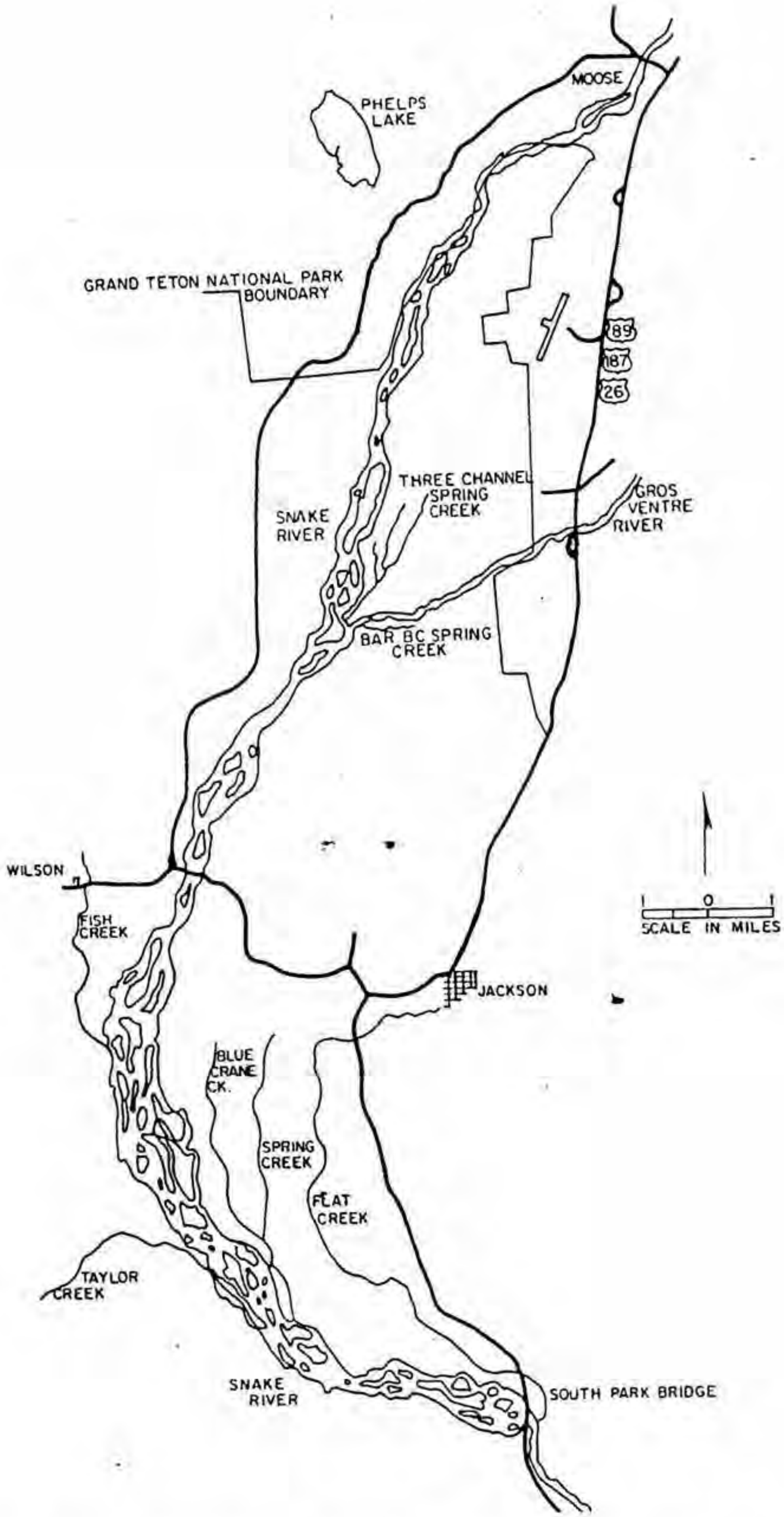


FIGURE 5 Project area and tributary streams (Kiefling 1978).

overwintering habitat appears to result in high mortality in young age cutthroat classes in the main river system (Kiefling 1978).

The diet of the Snake River Cutthroat trout is made up largely of aquatic and terrestrial insects; however, larger size classes of fish are quite opportunistic and will feed upon fish and small mammals (Kiefling 1978).

Mountain Whitefish: Mountain whitefish are very abundant within the project area and prefer fast, deep water, but are often found in riffle areas in the summer. They are mainly benthic feeders, relying mostly on chironomids and trichoptera larvae. Spawning activities begin in September and may last through November. The Snake River and its tributaries are major spawning areas for this species (Kiefling 1978).

Non-Game Fishery

The non-game fish populations are composed almost exclusively of Utah suckers (Catostomus ardens) and Bonneville redside shiners (Richardsonius balteatus hydrophlox). Based on 1985 Department data, it is estimated that the river contains about 8,400 suckers per mile (840 pounds per mile). Estimates of redside shiner densities are not available. Other non-game fish include speckled (Rhinichthys osculus) and longnose dace (Rhinichthys cataractae), Utah (Gila atraria) and leatherside chub (Gila copei) , mottled (Cottus bairdi) and Piute sculpin (Cottus beldingi), and mountain (Pantosteus playrhybchus) and bluehead suckers (Catostomus discobolus). These fish provide important forage for game fish (U.S. Bureau of Reclamation of 1984, Kiefling 1981, Ray 1984) and bald eagles and osprey feed on the larger species.

Aquatic Invertebrates

Aquatic invertebrates are a major food source for cutthroat trout and other game fish. Kroger (1967) did a comprehensive study of the project area invertebrate population and found that caddisflies, stoneflies, mayflies and true flies (dipteran species) made up 98 percent of the total biomass of organisms he sampled; caddisflies were the most abundant.

Terrestrial Resources

The Snake River in the project area supports a wide variety of wildlife including many species of songbirds, waterfowl, water birds, raptors, numerous mammals, amphibians, and reptiles. Thomas et al. (1980) noted that riparian communities are among the most important and critical of wildlife habitats. Functioning as an ecotone between aquatic and terrestrial habitat, riparian ecosystems support a diversity of wildlife communities which are influenced by and respond to various vegetation characteristics, i.e., structural diversity, plant diversity and successional stage. The project area provides a considerable amount of edge between the numerous stream channels and islands, the floodplain forest, sagebrush-grassland and upland forest type. Due to the variability in the herbaceous layers of vegetation, the vertical and horizontal diversity is very high. This overall diversity translates directly into a complex assemblage of wildlife species (Brinson et al. 1981, Simpson et al. 1982).

Vegetation

Vegetation types within the project area are typical of the Snake River drainage (Figure 6). The vegetation types near the river and streams, or in areas where the water table is high enough to support wetland plant species, are composed of forested (Populus spp.), scrub-shrub (Salix spp.), emergent (Typha spp., Carex spp. and Scirpus spp.), and aquatic bed (Potamogeton spp. and Elodea spp.) wetlands (Cowardin et al. 1979). Sagebrush-grassland and evergreen trees dominate the upland sites (see Appendix 1 for complete plant species list). The common vegetation communities found within the project area include the following types:

Upland Forest Type: The upland type is composed of mixed conifer forest, dominated by lodgepole pine (Pinus contorta) at lower elevations (6,300 to 7,800 feet), and subalpine fir (Abies lasiocarpa) and Englemann spruce (Picea engelmannii) at higher elevations (7,800 to 10,000 feet). Douglas-fir (Pseudotsuge menziessii) is scattered throughout lodgepole pine forests, growing mainly on ridge tops and south and east facing exposures. Nearly pure stands of Englemann spruce occasionally occur in canyons and ravines. Characteristic understory vegetation in lodgepole/Douglas-fir forests is composed of grouse wnortleberry (Vaccinium scoparium), bearberry (Arctostaphylos uva-ursi), heartleaf arnica (Arnica cordifolia), elk sedge (Carex geyeri), pine grass (Calamagrostis rubescens), and bluejoint reedgrass (Calamagrostis canadensis). Common understory vegetation in spruce-fir forests includes mountain clover (Pachistima myrsinites), Utah honeysuckle (Lonicera utahensis), and twinflower (Linnaea borealis).

Sagebrush-Grassland: The sagebrush-grassland vegetation type occurs on foothills and on glacial outwash plains and terraces above the floodplain. Big sagebrush (Artemisia tridentata) the dominant shrub commonly mixed with antelope bitterbrush (Purshia tridentata). Characteristic herbaceous species include arrowleaf balsamroot (Balsamorhiza sagittata), wild buckwheat (Eriogonum spp.), biscuitroot (Lomatium spp.), fleabane (Erigeron spp.), cinquefoil (Potentilla fruticosa), pussytoes (Antennaria spp.), Idaho fescue (festuca idahoensis), junegrass (Koeleria cristata), western wheatgrass (Agropyron smithii), bromegrass (Bromus spp.), Kentucky bluegrass (Poa pratensis), and needlegrass (Stipa spp.).

Floodplain Forest: Stands of narrowleaf cottonwoods (Populus angustifolia) and willows (Salix spp.) intermixed with Englemann and blue spruce (Picea pungens) typically dominate the riverine floodplains and stable islands associated with this reach of the Snake River. Characteristic understory shrubs include silverberry (Eleagnus commutata), alder (Alnus incana), and (Rosa woodsii), with herbaceous forbs like valerian (Valerianna spp.), horsetail (Equisetum fluviatile), clover (Trifolium spp.) sedge (Carex spp.) and Kentucky bluegrass.

Scrub-shrub: This vegetation type is commonly associated with gravel bars, dikes and along spring creeks. These areas have high water tables and are

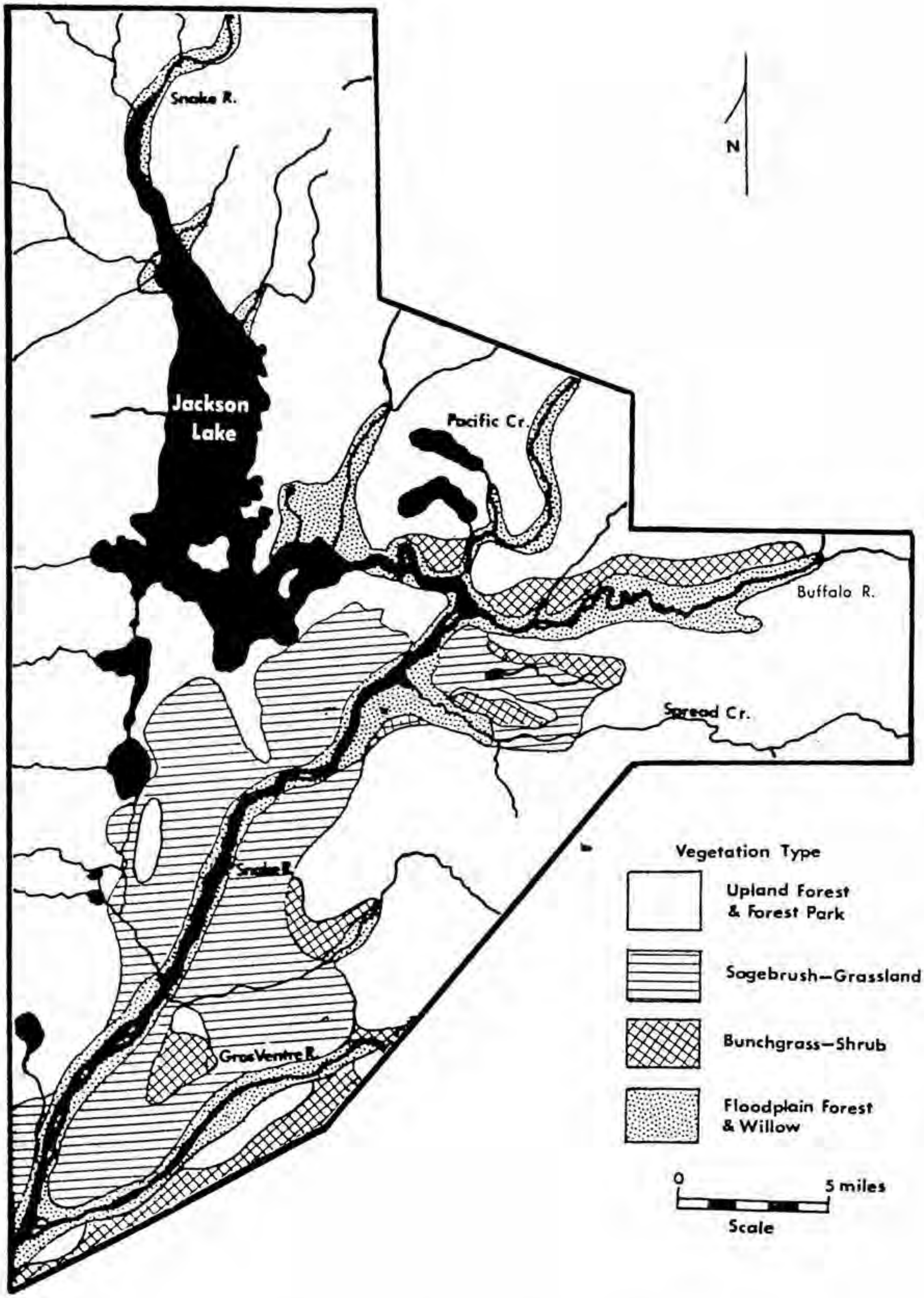


Figure 6. Major vegetation types found within the Snake River Drainage in the Jackson Hole (from Houston 1968).

subjected to frequent flooding. Willow and alder are the dominant plant species. Grass species include quack grass (Briza minor), cheatgrass (Bromus tectorum), smooth brome (Bromus ciliatus), sedge and Kentucky bluegrass. Numerous forbs have colonized these sites such as mullein (Verbascum thapsus), fireweed (Epilobium angustifolium), hound's tongue (Cynoglossum officinale), and dandelion (Taraxacum spp.).

Emergent Wetland: This vegetation type occurs around the margins of ponds, backwater sloughs and shallow wetland depressions. Cattail (Itpha Latifolia) and hardstem bullrush (Scirpus acutus) dominate the permanent water regimes, whereas Baltic rush (Juncus balticus) and common threesquare (Scirpus pungens) are most common in the seasonally flooded areas.

Grass/Sedge Meadows: Sedges and grasses are the dominate plant cover within this vegetation type. Sedges are more dominant in mesic sites and grasses in the more xeric areas. Common plant species include needlegrass, spike sedge (Carex spp.), timothy (Phleum pratense), fowl bluegrass (Poa palustris), smooth brome, tufted hairgrass (Deschampsin caespitosa), bentgrass (Agrostis spp.) and clover. Willows are commonly located adjacent to streams and ditches within this cover type.

Gravel/Cobble/Sand Islands and Bars: Much of the islands and bars within the levees and the active floodplain are made up gravel, cobble, and sand. Annual channel shifts leave new exposed of cobbles, gravel, and sand after each period of high water. On such unstable sites, the sparse and scattered plant cover is primarily composed of rushes, horsetails, foxtail muhly (Muhlenbergia anadina), pullup muhly (Muhlenbergia filiformis), shortawn foxtail (Alopecurus aequalis), willow dock (Rumex salicifolius), lamb's quarters (Chenopodium spp.), Rocky Mountain buttercup (Ranunculus populago), yellow sweetclover (Melitotus officinalis), and cudweed (Gnaphaliu spp.). Early stages of willows, mountain alder, and narrowleaf cottonwood are dominant species on the more stable, elevated islands and sandbars within the stream beds. Along stream banks and river banks there are clumps of dogwood (Cornus spp.), silverberry and willows; and several grasses mannagrass (Glyceria spp.), timothy, cheatgrass, meadow barley (Hordeum brachyantherum), and others grasses; and forbs (lambsquarters, prickly lettuce (Lactuca integrata), pepperweed (Lepidium spp.), penstemon (Penstemon spp.), and yarrow (Achillea lanulosa).

Aquatic Bed: According to Kiefling (1978), the most prevalent aquatic and semi-aquatic vegetation found in the flood-channels and tributaries are watercress (Rorippa nasturtium-aquaticum), pondweed (Potamogeton spp.) and white water crowfeet (Ranunculus aquatilis). Hayden (1967) found an association of watercress with shoreline areas, pondweed with silt bottom areas, and white water crowfeet with the gravel-rocky bottom environs. Other major aquatic and semi-aquatic plants found in the drainage are star duckweed (Lemna triculca), water milfoil (Myriophyllum spp.), mare's tail (Hippuris vulgaris), monkey flower (Mimulus glabratus), moss and algae. Blum (1956) divided the river algae into two types, phytoplankton and benthic. He found that unicellular phytoplankton live in association with the benthic types (filamentous and encrusting algae). Kroger (1967) notes the growth of filamentous algae was not static throughout the year, and that mats of algae are apparently as abundant in deeper water as in riffle areas.

The habitat types of the Snake River floodplain within the general project area and their approximate acreage are listed below:

Habitat Type	Acres
Floodplain forest	5,718
Scrub-shrub	916
Emergent wetland	1,693
Grass/sedge Meadow	662
Gravel/cobble/sand	1,514
Aquatic bed	259

BIRDS, GENERAL

Vegetative characteristics provide an abundance of natural cover in lowland cottonwood habitats. Nesting or resting habitat is available in the tree canopy and tree boles, shrub layer, ground cover and streambanks. Finch (1986) found the total number of breeding pairs highest in low-elevation sites dominated by plains cottonwood followed by mid-elevation narrowleaf cottonwood communities. Alpine willow communities had the lowest number of breeding pairs. Furthermore, more bird species preferred to breed in habitat with larger shrub/tree size, canopy height, and number of vegetative layers.

Utilizing guilds to indicate the capability of habitats to sustain avian populations is an accepted approach to managing diverse riparian habitats (Severinghaus 1981, Verner 1984, Block et al. 1986). The riparian vegetation within the project area provides a variety of insects, seeds, and berries, creating a diversity of bird foraging guilds. Of the six different foraging guilds identified by Finch (1989, in press), the majority of avian feeders were along the ground in the understory of the cottonwood community. The increased species richness in lowland cottonwood habitats is partially explained by an increased number of guilds and number of species per guild resulting from extensive habitat layering (Finch 1989, in press).

Based on available information within and adjacent to the project area, over 150 different species of birds have been observed. Of those, 119 are documented breeders with the remaining species either observed or expected to occur within the project area. Therefore, 79 percent of the area breeding birds are associated with the cottonwood-riparian and wetland habitat types found along the Snake River. Various species congregate and use the cottonwood-riparian community for feeding and resting during spring-fall migration, while others are primarily winter residents. Refer to Appendix 3 for a complete bird species list and their expected seasonal occurrence.

Passerine Birds: Of the total number of bird species identified within the project area, approximately 75 percent are considered passerine or songbirds. Nearly 65 percent of the passerines are probable or documented breeders that nest, feed, find cover in the riparian vegetation, and are considered yearlong residents. Common passerine bird species that use the cottonwood/willow riparian and associated wetland habitat types along the

Snake River include: mourning dove (Zenaidurs macroura), black-capped chickadee (Parus atricapillus), mountain bluebird (Sialia currucoides), Swainson's thrush (Hylocichla ustulata), warbling vireo (Vireo gilvus), MacGillivaray's (Oporornis tolmiei), yellow-throat (Geothlypis trichas), and yellow warblers (Dendroica petechia), western tanager (Piranga ludovicianna), western wood pewee (Contopus sordidulus), tree (Iridoprocne bicolor) and violet-green swallows (Tachycineta thalassina), dusky flycatcher (Empidonax oberholseri), lazuli bunting (Passerina amoena), red-winged blackbird (Agelaius phoeniceus), and Lincoln (Melospiza lincolnii), song (Melospiza melodia), savannah (Passerculus sandwichensis), and white-crowned sparrows (Zonotrichia leucophrys).

Raptors: A variety of raptors use the river reach within the project area and are either seasonal or yearlong residents; all are documented breeders within the area. This reach of the Snake River provides avian predators with an abundance of prey, perching sites, nesting sites, roosting sites and a relatively dense multi-layered vegetative buffer zone from human disturbance. Falcons found within the project area include the American kestrel (Falco sparverius), merlin (Falco columbarius), prairie falcon (Falco mexicanus), and the peregrine falcon (Falco peregrinus), an endangered species. Crepuscular and nocturnal avian predators such as the western screech-owl (Otus asio), great horned owl (Bubo virginianus), long-eared owl (Asio otus), and northern saw-whet owl (Aegolius acadicus) have also been observed. The more abundant hawks include the red-tailed (Buteo jamaicensis), Swainson's (Buteo swainsoni), sharp-shinned (Accipiter striatus), Cooper's (Accipiter cooperii), and northern goshawk (Accipiter gentilis). Ospreys (Pandion haliaetus) are also common in the project area and are very dependent on the riverine system, feeding almost exclusively on fish. They perch and nest in partially dead or dead standing trees not very far from water. Man-made structures are also frequently used for nesting. Annually, 3 to 4 pair of osprey nest within the project area (Figure 7). Golden eagles (Aquila chrysaetos) are yearlong residents as well as the endangered bald eagle (Haliaeetus leucocephalus). Golden eagles are usually observed between the floodplain forest and upland forest type, unlike the bald eagle which spends a large portion of time nesting, perching and feeding along the river.

Waterfowl: Resident and migratory waterfowl use the Snake River and its tributaries for spring/fall staging, breeding, nesting, brood rearing, and wintering habitat (Figure 8). Although ducks' numbers may fluctuate annually, on average (1982-87), approximately 1,320 dabbling and 666 diving ducks winter along the river (Fralick 1989). Within the project area, an average of 66 dabbling and 33 diving ducks winter along each mile of river. Common dabbling ducks include mallard (Anas platyrhynchos) and American wigeon (Mareca americana), while diving ducks are comprised of Barrow's goldeneye (Bucephala islandica), common goldeneye (Bucephala clangula), and ring-necked duck (Aythya collaris). During the winter, an estimated 466 diving and 924 dabbling ducks inhabit the South Park area. From South Park Bridge north to Wilson Bridge, the winter duck densities frequently average 139 ducks per mile of river and/or tributaries.

Canada geese (Branta canadensis) use the Snake River and its tributaries for breeding, nesting, brood rearing, and winter habitat (Figure 9). The most

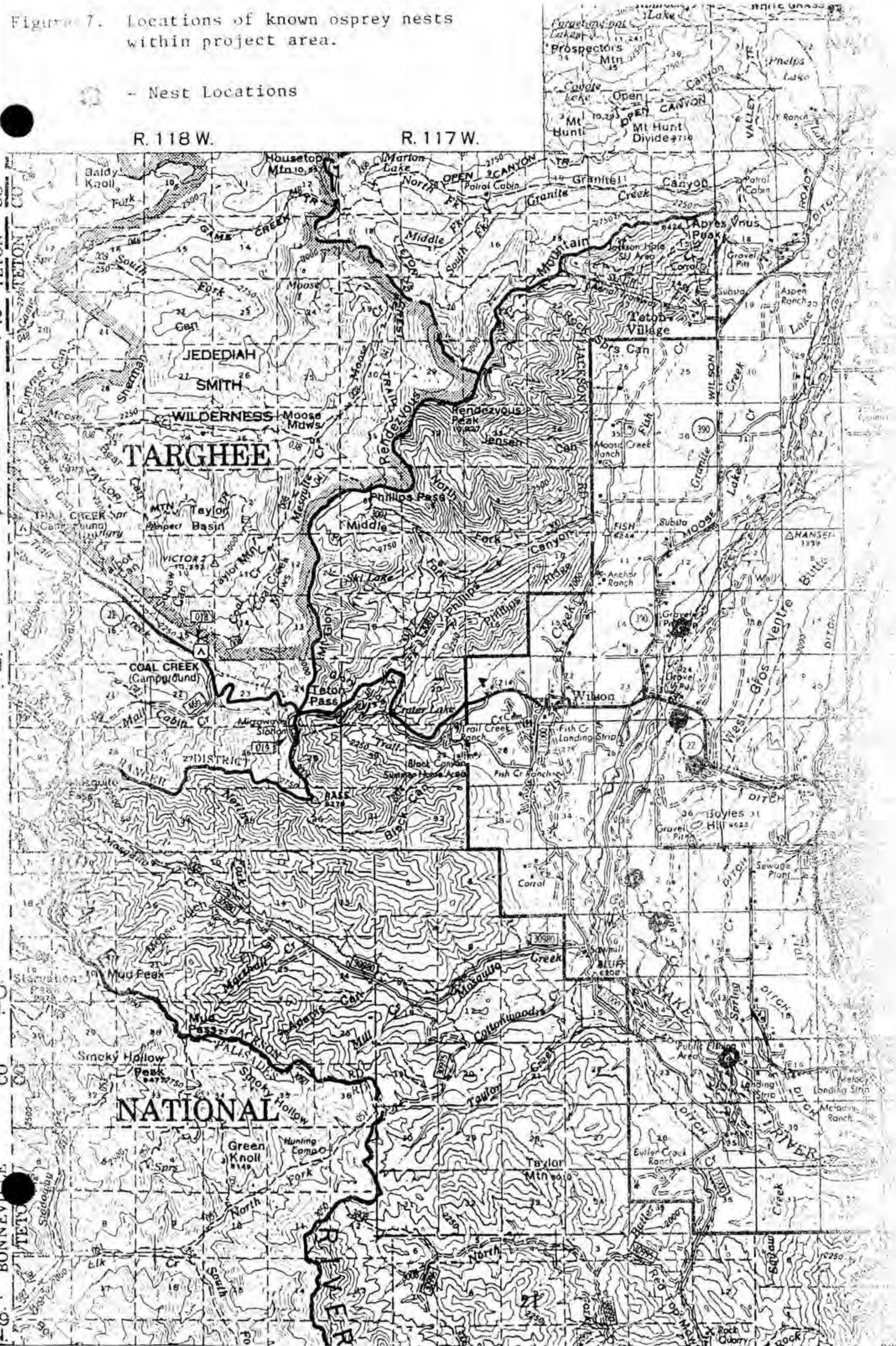


Figure 7. Locations of known osprey nests within project area.

- Nest Locations

Figure 8. Crucial habitat areas waterfowl (Fralick, 1989).

- Brood rearing
- Crucial winter range
- Wintering areas

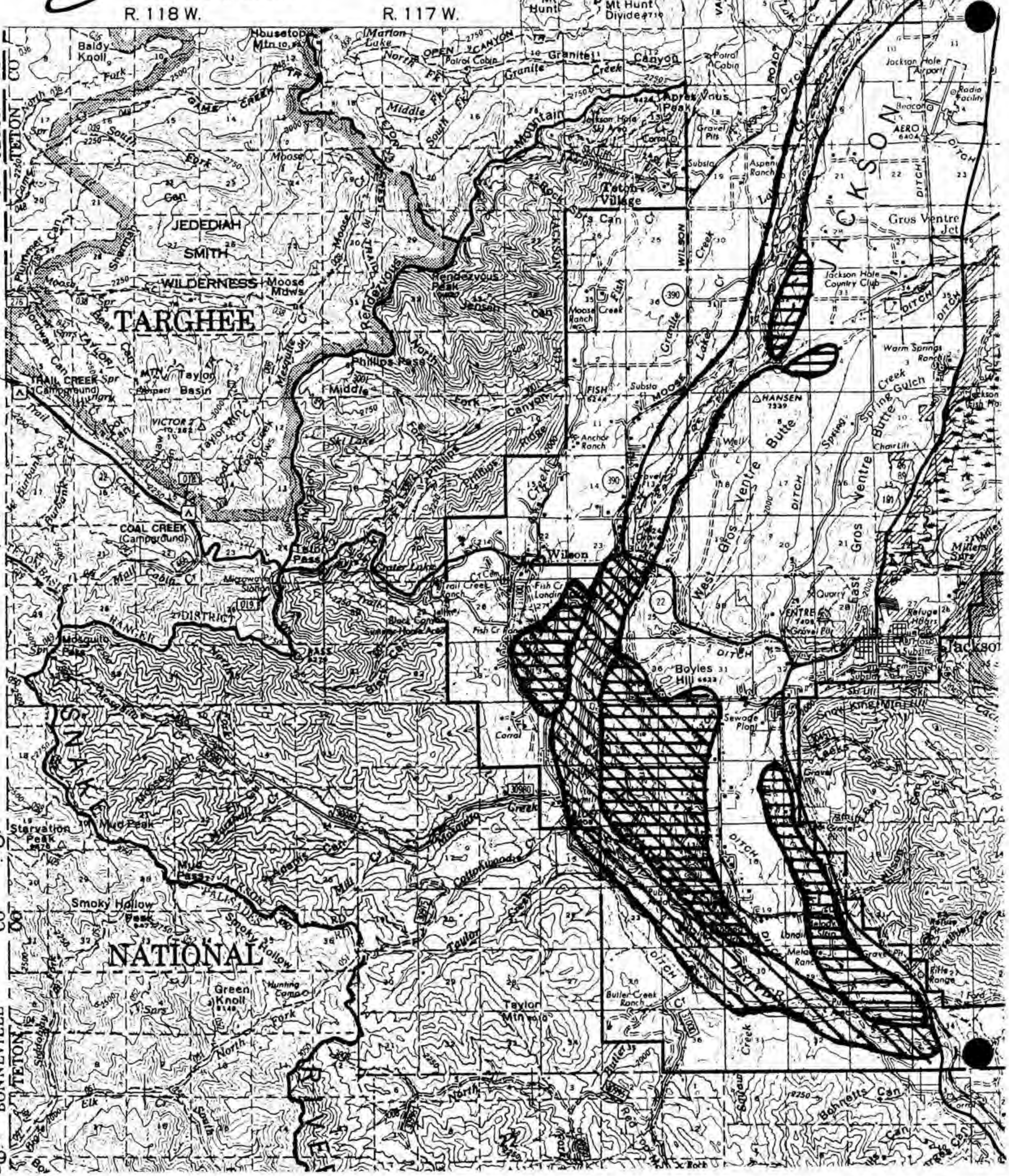
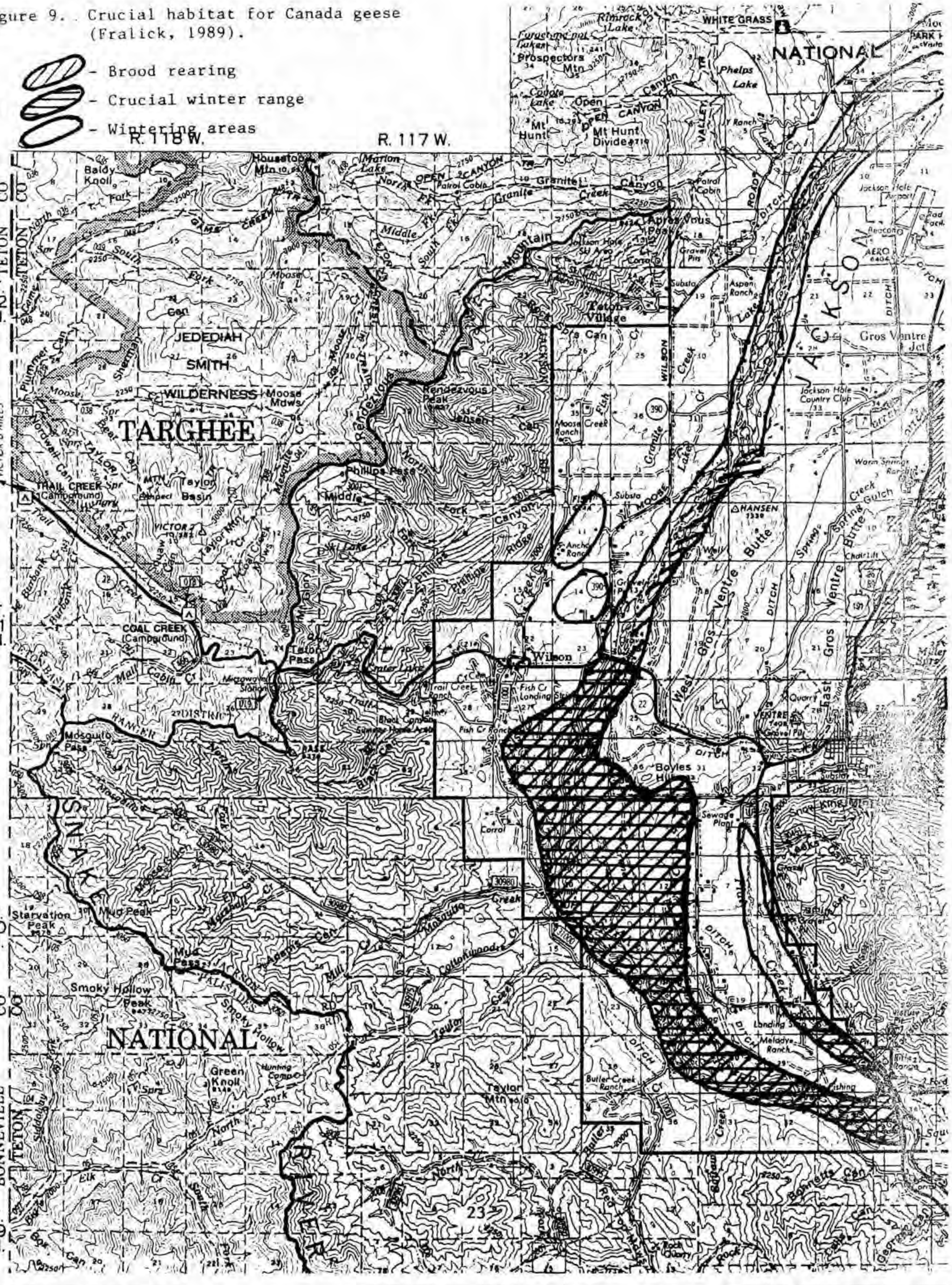


Figure 9. Crucial habitat for Canada geese (Fralick, 1989).



important nesting areas for Canada geese on the Snake River south of Wilson Bridge are around the confluence of Blue Crane Creek and between Fish Creek and the confluence of Spring Creek. North of the Wilson Bridge, the highest goose nesting concentration is around the confluence of the Gros Ventre River. These are areas with a predominance of stable islands where there is cover, mostly in the form of logs and willows, which reduces losses to avian predators.

From 1983 to 1988 an average of 20 breeding pairs of Canada geese used the Snake River and it's tributaries between South Park Bridge and Wilson Bridge (Fralick 1989). The average breeding pair density of Canada geese for this lower project area river reach was 2.0 pairs per mile. During the same period, an average of 22 breeding pairs of geese use the area near the confluence of the Gros Ventre River. Densities of breeding geese in this upper section of the project area averaged 5.5 pairs per mile. The average number of breeding pairs of Canada geese located within the immediate vicinity of the project during this 6 year period was 30, or 1.5 pairs per mile. Of these breeding geese, it is estimated that 80 percent nested.

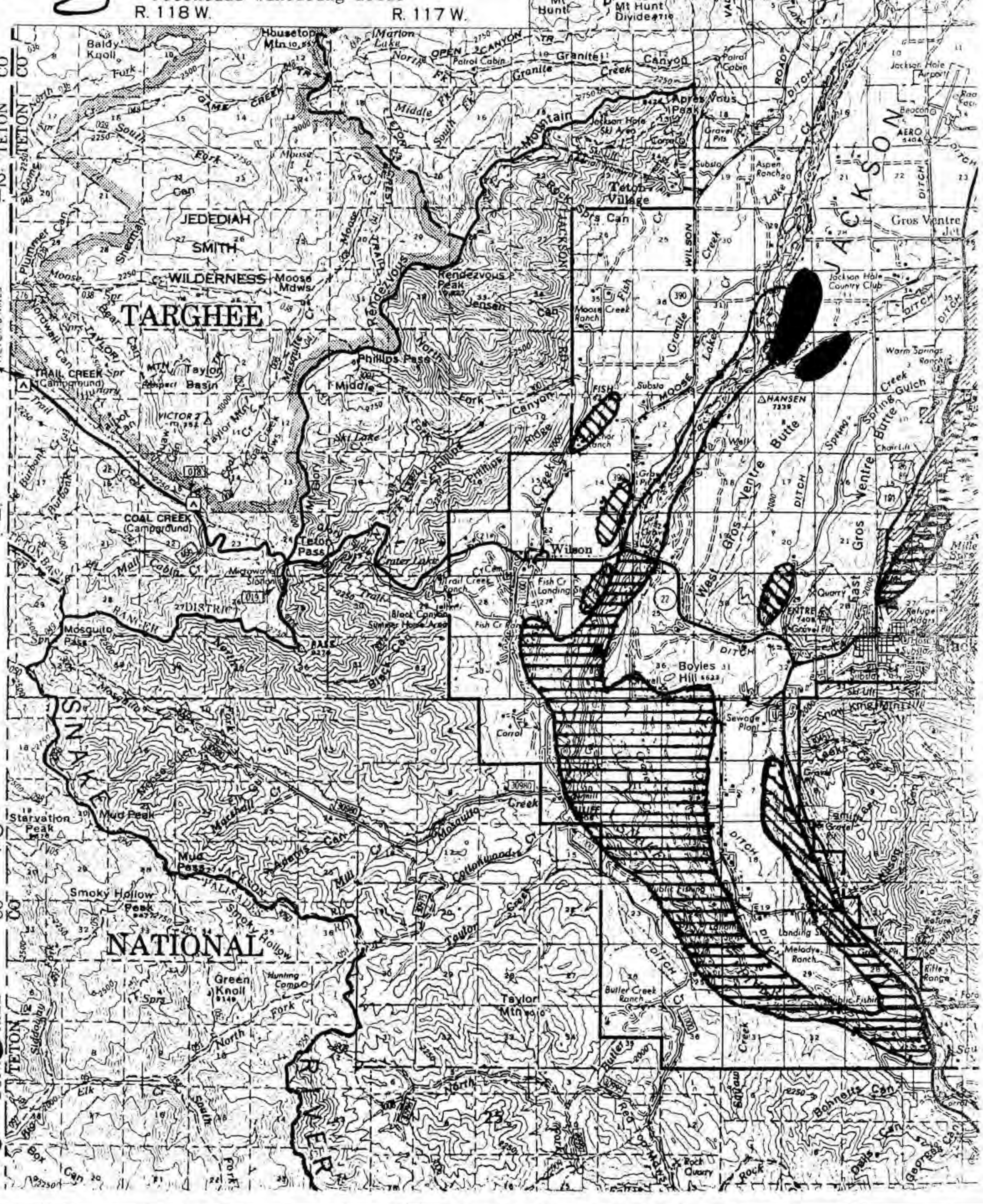
In the fall (September-October) 1,000-5,000 Canada geese annually use the spring creek tributaries in the project area. During this crucial fall staging period, densities may average from 50-250 geese per mile. Typically, Spring and Fish Creeks receive the majority of the fall use by geese. Canada geese densities of 11 to 17 geese per mile may be observed within the project area during this time.

Annually, approximately 100-120 trumpeter swans (<u>Olor</u> <u>buccinator</u>) winter in the Snake River outside of Yellowstone National Park in Wyoming. This number is equivalent to 1.6 to 1.8 swans per mile of river. Within the project area, crucial winter habitat for trumpeter swans is primarily located from Wilson Bridge downstream (Figure 10). Annually, 7 to 14 breeding pairs of trumpeter swans and their young relied on the South Park, Fish Creek, and lower Flat Creek wintering areas. Fish Creek is the most important and heavily populated of the three wintering sites. Lower Flat Creek had the lowest use, with 7 swans per year from 1982-88. During the period from 1982-86, an average of 45 swans used these winter areas for 90 to 135 days, which equates to 5,951 swan days of use per year. From South Park Bridge to Wilson Bridge an average of 4.5 swans wintered per mile of river. Use of these winter sites within the project area represented approximately 35 percent of swan winter habitat for the Jackson Hole area.

Preferred foraging sites for swans typically occurs in the spring fed tributaries of the Snake River where foraging substrates consist of a deep organic silt muck bottom and submerged rooted vegetation. These unique foraging areas are found in the South Park, lower Flat Creek and Fish Creek. Swans took advantage of these areas during 75 percent of the winter. Within these locations, there are approximately 70 acres of foraging habitat. Based on comparable habitat monitored at the National Elk Refuge, the swan winter forage in these creeks could support about 86-154 swan days/acre. The remaining 98 acres of foraging habitat within the project area would support an estimated 10-65 swans/acre.

Figure 10. Crucial habitat for trumpeter swans (Fralick, 1989).

- Brood rearing
- Wintering areas
- Crucial winter range
- Potential wintering areas



An estimated 4 to 8 breeding pairs of greater sandhill cranes (Grus canadensis) nest and rear broods each year in the project area. Most sandhill crane production occurs in beaver ponds and seasonally flooded emergent wetland habitats with low levels of human disturbance. Annually, 30-100 sandhill cranes use the meadows between the Department's South Park Habitat Unit and Spring Creek as a spring migration stopover (Figure 11). Typically, native hay meadows are used by these cranes during the summer as feeding and roosting areas. Subadult groups begin congregating on fall pre-migration staging areas as early as mid-August and adult birds and chicks by mid-September. For the latter group, the movement from higher elevation habitats appears to be triggered by hard freezes which kill the late summer crop of insects. The National Elk Refuge is a major staging area for these birds. The fall migration out of the valley generally begins by late-September (Lockman et al. 1985).

A great blue heron (Ardea herodias) rookery of about 150 pairs (the largest in the State) is located within the South Park area at T41N, R117W, Section 35. These birds are observed all along the Snake River and its tributaries within the project area during the spring, summer, or fall. A few birds may overwinter within the project area. Great blue herons feed primarily on fish, aquatic insects, frogs and even small mammals that are readily found along water edges or in the shallows. Great blues herons nest in colonies, building nest structures in cottonwood trees along the river.

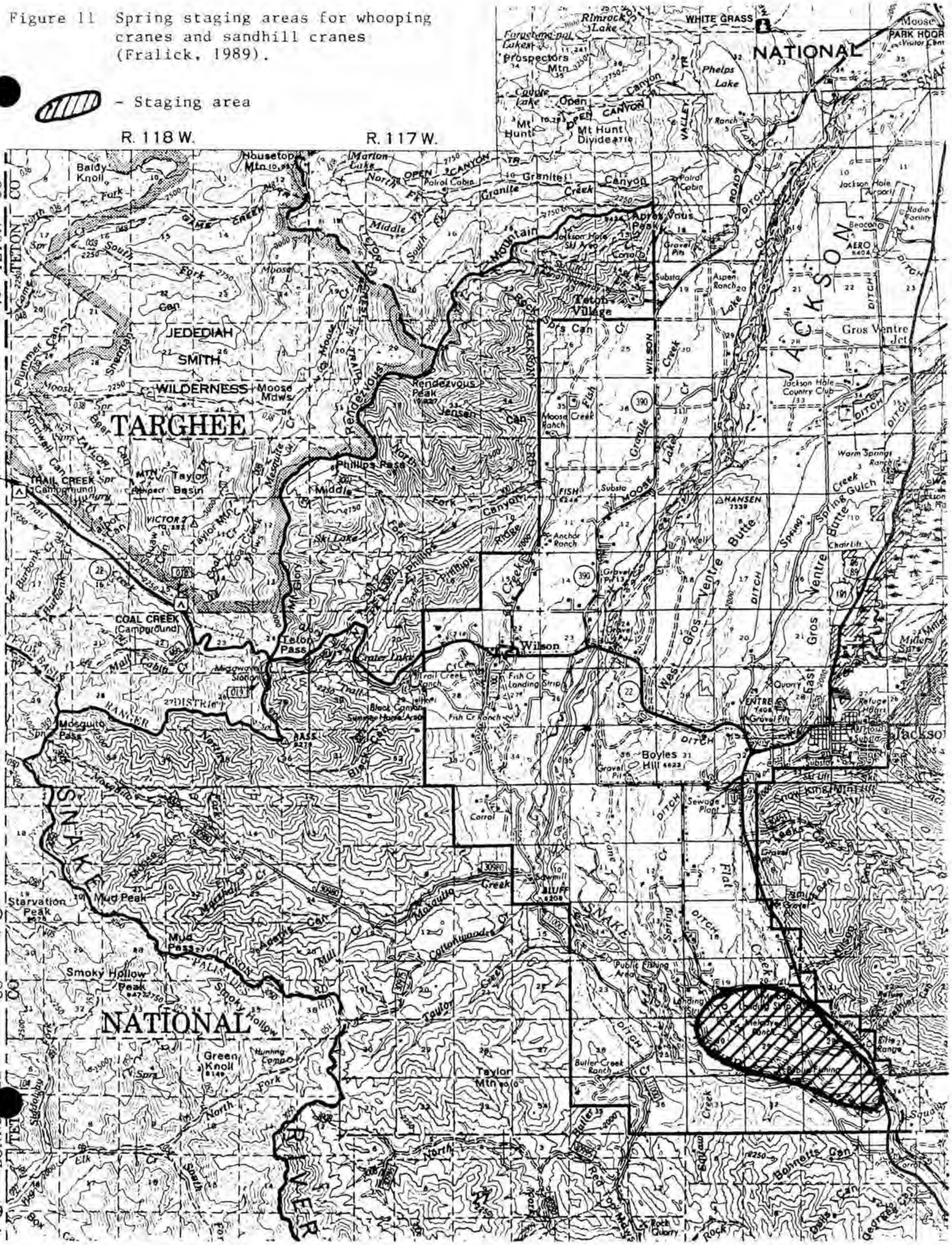
Small Mammals

A number of small mammalian species use the project area on a permanent, seasonal, or transient basis. Refer to Appendix 4 for a complete mammal species list. Populations of small mammals are cyclic in nature with densities varying by season. However, if sufficient habitat is available, small mammal densities are relatively high (Clark and Stromberg 1987). The multi-layered herbaceous vegetation provides a diverse habitat for various mammal species found in the area.

The masked (Sorex cinereus cinereus), dusky (Sorex monticolus obscurus) and northern water shrew (Sorex palustris navigator) are documented in the project area and prefer mesic habitats with a source of water nearby. The project area provides an abundant terrestrial and aquatic insect food source for shrews. Vole species include the red-backed (Clethrionomys gapperi), heather (Phenacomys intermedius intermedius), montane (Microtus montanus), meadow (Microtus pennsylvanicus), water (Microtus richardsoni macropus) and long-tailed (Microtus longicaudus longicaudus) voles. Area riparian habitats supply voles with an abundance of plant material, seeds, fruits and insects for food as well as leaf litter, logs and windfallen trees for security. Deer mice (Peromyscus maniculatus) and western jumping (Zapus princeps) mice are also found in the cottonwood understory. Squirrels found in the project area include the golden mantled ground squirrel (Spermophilus lateralis), yellow-bellied marmot (Marmota flaviventris), red squirrel (Tamiasciurus hudsonicus), Unita ground squirrel (Sperophilus armatus) and least chipmunk (Tamias minimus). Other small mammals common to the area include the northern pocket gopher (Thomomys talpoides), bushy-tailed woodrat (Neoktoma cinerea), stripped skunk (Mephitis mephitis hudsonica), long-tailed weasel

Figure 11 Spring staging areas for whooping cranes and sandhill cranes (Fralick, 1989).

- Staging area



(Mustela frenata) and porcupine (Erethizon dorsatum). Predators in the area, such as hawks, owls, weasels, foxes, bobcats (Felis rufus pallescens) and coyotes (Canis latrans), all prey on these small mammals.

Common furbearers in the project area include the mink (Mustela vison), muskrat (Ondatra zibethicus), river otter (Lutra canadensis pacifica), and beaver (Castor canadensis). Mink are found in relatively lower densities within the project area, preferring riverbottom habitats that provide adequate cover and an abundant food source. Selected prey items include fish, amphibians, birds, and various small mammals, fruits and berries. Although economically important as furbearers, mink are not commonly harvested by trappers within the project area.

Muskrats are a common resident of ponds, oxbows, and spring creeks within the project area. They primarily feed on aquatic vegetation, which is also used for lodge construction. Muskrats are economically important as a furbearer and are annually harvested within and adjacent to the project area.

The Snake River is identified as one of the most significant areas in Wyoming for the river otter (Rudd et al. 1986). A recent aerial survey (12 January, 1989) by the Department recorded sign or visual observations of at least 7 otter between the South Park Bridge and Jackson Lake Dam. Three of these records were within the project area. Otters use log jams, pools and oxbows as foraging areas due to the large number of fish which congregate in these habitats. The following structures are used by otters as den and resting sites: 1) beaver bank dens, 2) beaver lodges, 3) log jams, 4) brush log piles, and 5) naturally undercut banks. This rare furbearer species is not harvested, and is protected by State law.

Beavers are another economically important furbearer and are annually harvested in and adjacent to the project area. Beavers rely heavily on cottonwood trees for lodge and dam construction and prefer the willow shrub understory as a food source. Prime habitat for this furbearer is found along spring creeks, side channels, and oxbows. Coyotes, bobcats and lynx will all prey on beaver.

Coyotes, red foxes (Vulpes vulpes), bobcats and the occasional lynx (Felis lynx canadensis) are the largest of the terrestrial predators found within the project area and also figure into the fur trade. These predators are opportunistic, preying on the various smaller mammal species, bird species or herptile species they encounter.

Avian mammals include the hoary (Lasiurus cinereus cinereus), silver-haired (Lasionycteris noctivagans), long-eared (Myotis evotis evotis), and little-brown (Myotis lucifugus carissima) bats. Insects, both terrestrial and aquatic, are abundant along the riparian bottoms supplying these bats with a reliable food source.

Large Mammals

Elk: The elk (Cervus elaphus nelsoni) population in the Jackson Hole area is one of the largest in North America. During the summer, up to 15,000 elk inhabit over 1,000 square miles. The elk summer range includes all of Jackson Hole and surrounding mountains. Portions of the herd summer in southern Yellowstone National Park, as far as 60 miles from their winter range (Clark 1981).

Winter snow accumulation reduces food availability forcing elk to migrate to lower elevations. Generally migration occurs during the month of November. Surveys taken from 1949-67 indicate that migration routes have changed over time. About 80 percent of the population migrated east of Grand Teton National Park several decades ago, but today nearly 80 percent migrate through Teton Park (Clark 1981).

During winter, the population concentrates in smaller areas. The largest of these areas is the 24,000 acre National Elk Refuge where the population may exceed 10,000. Another important wintering area is the Department's 1200-acre South Park Habitat Unit, located approximately 6 miles south of Jackson (Figure 12). These refuges maintain winter range and supplemental feeding areas for elk.

The project area encompasses portions of the Fall Creek and Jackson Department's Elk Herd Units (Figures 13 and 14). The project area north of the Wilson bridge lies within the Jackson Elk Herd Unit and is used as spring, summer and fall range. The number of elk from this herd foraging on seasonal ranges within the project area is believed to be small; however, a major fall migration route for this herd to the National Elk Refuge lies within the project area north of the Gros Ventre River.

The southern half of the project area is within the Fall Creek Elk Herd Unit. The Department's South Park Habitat Unit serves as a crucial winter range and supplemental feeding area for approximately 22 percent of the elk inhabiting the Fall Creek Herd. An average of 978 elk have wintered on the habitat unit over the last 5 years. During the winter of 1988-89, an estimated 1300 elk wintered on the unit and 200 elk wintered within the Snake River floodplain between South Park and Wilson Bridge. Although the majority of these elk summer in areas west of the project area, approximately 15 elk remained on the habitat unit throughout the year. The Department's land use objectives for the South Park Habitat Unit are provided in Appendix 5.

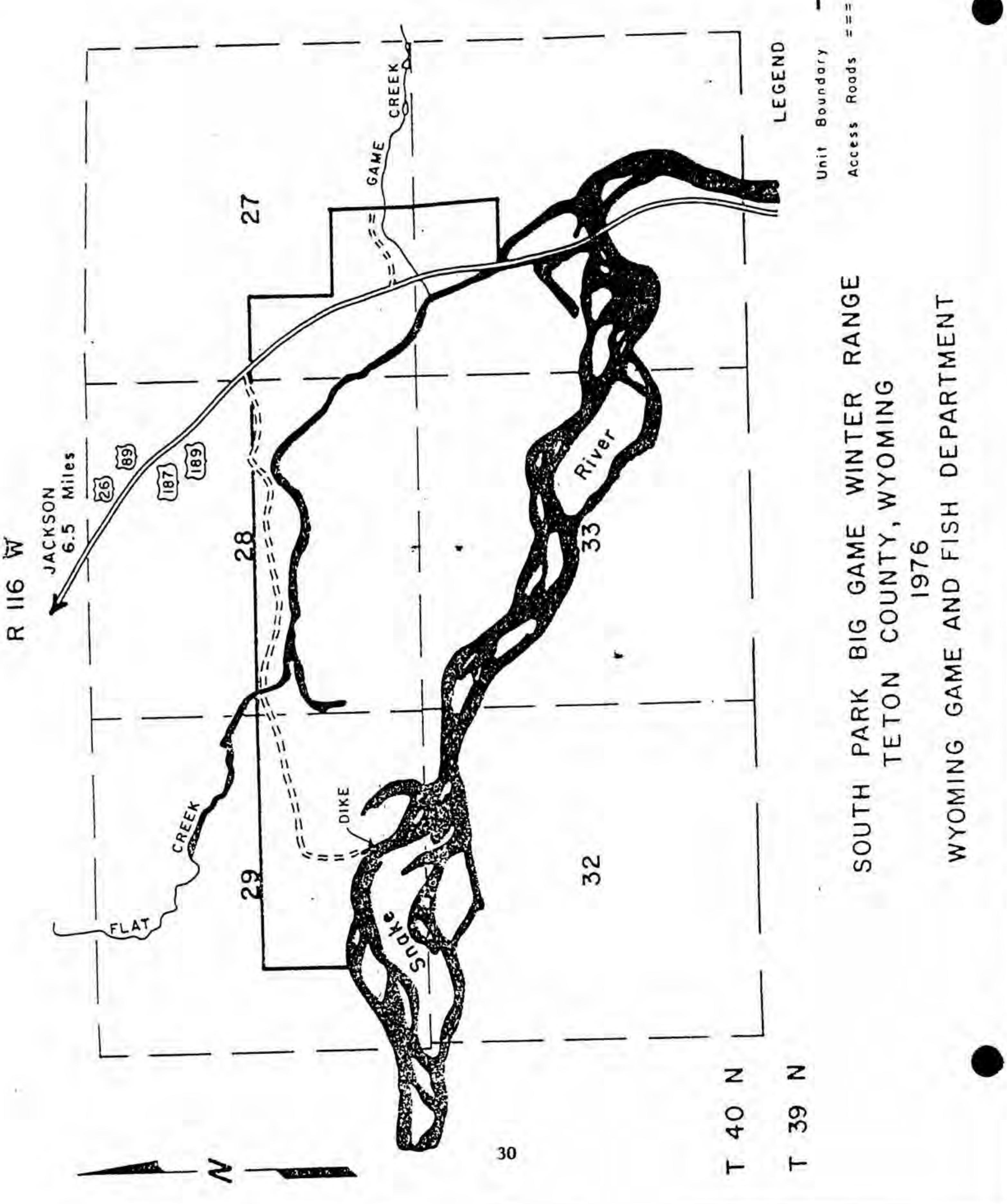
The Department's harvest, population objectives, and economic data for the Fall Creek Herd Unit are outlined in Table 4.

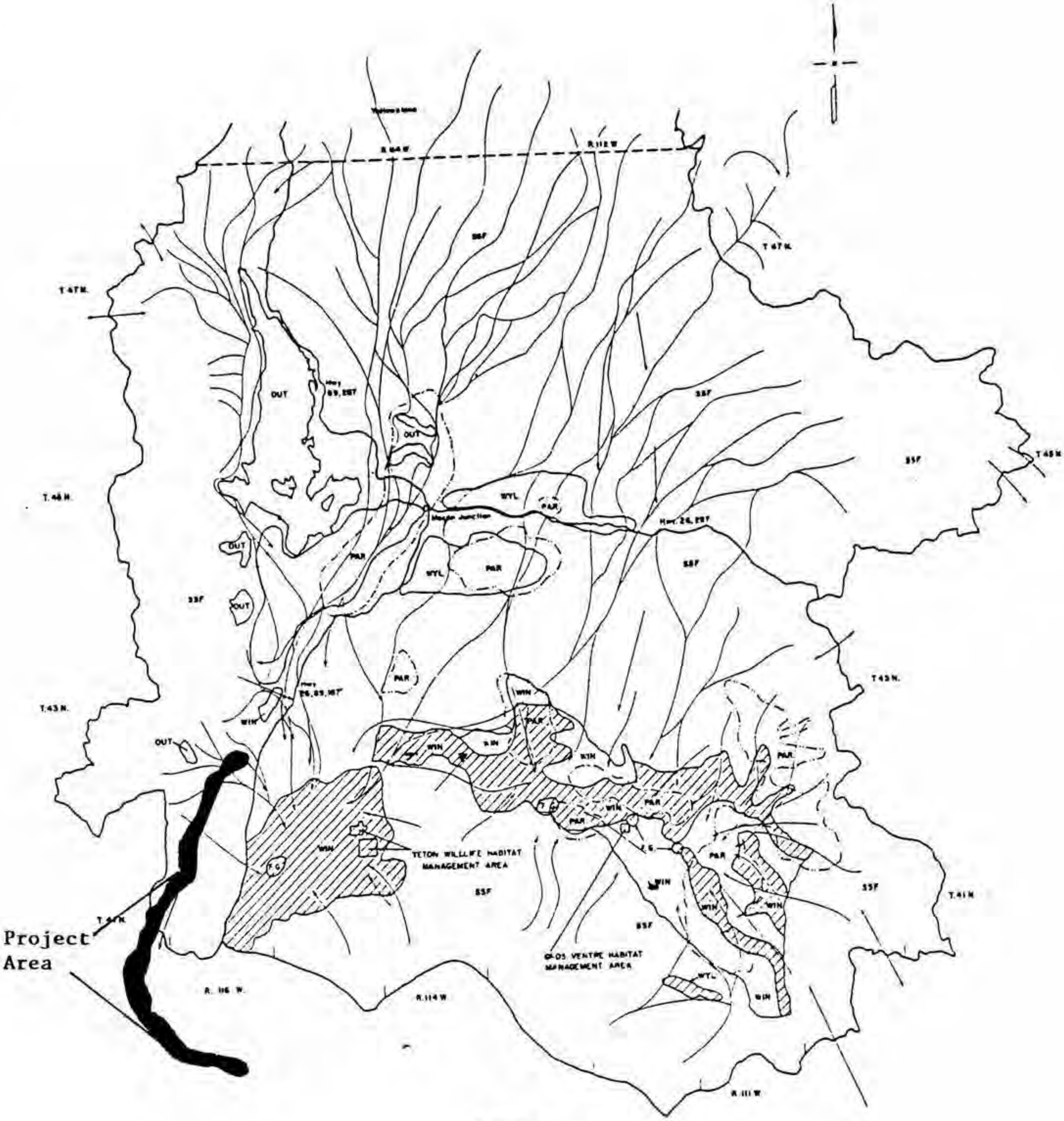
Table 4. Fall Creek Elk Herd Unit Statistics, 1983-1987 Average and 1988 recommended objectives (Fralick 1989).

Herd Unit Statistics -	1983-1987 (Avg.) &	1988 (Proposed)
Population	4200	4500
Harvest	638	1055
Hunters	2688	3516
Success	23%	30%
Recreation Days	13980	23210

Dollars Entering State's Economy $1,461,299

Figure 12 . The South Park Big Game Winter Range (Fralick, 1989).

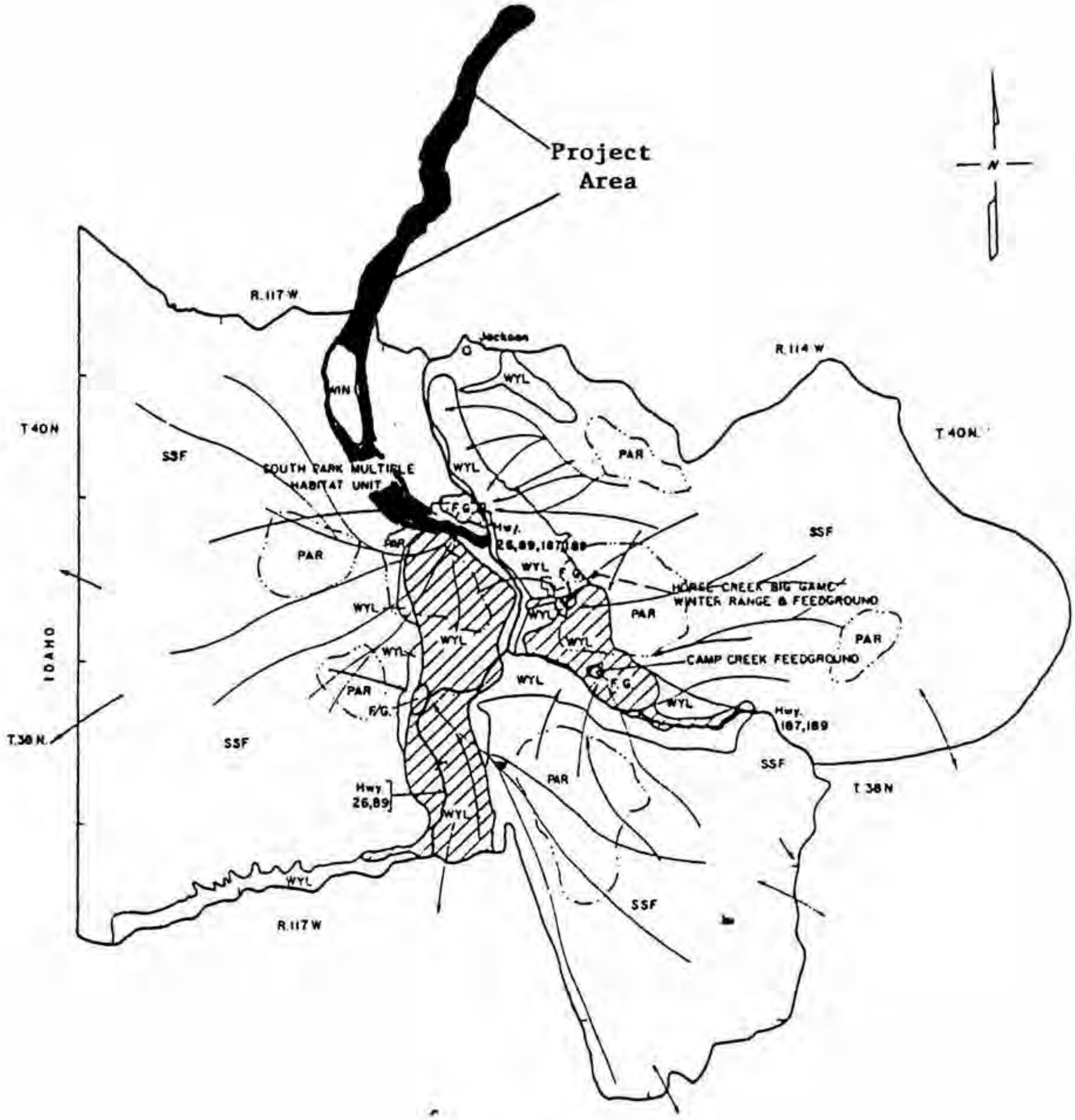




LEGEND

- Crucial Range
OUT - Habitat of Limited Use
→ - Migration Routes
PAR - Parturition area
SSF - Spring thru Full Range
WIN - Winter Range
WYL - Winter/yealong range

Figure 13. Seasonal range and distribution of the Jackson elk herd (WGFD 1988).



LEGEND

- (hatched) - Crucial Range
- OUT - Habitat of Limited Use
- → - Migration Routes
- PAR - Parturition area
- SSF - Spring thru Full Range
- WIN - Winter Range
- WYL - Winter/yearlong range

Figure 14. Seasonal range and distribution of the Fall Creek elk herd (WGFD 1988).

The harvest and population objectives for the Jackson Creek Herd Unit are not provided since the project area is not a significant component of this herd's range.

Moose: Shiras moose (<u>Alces</u> <u>alces</u> <u>shirasi</u>) are found throughout the upper Snake River drainage. Between 200 to 300 moose inhabit the valley throughout the year. During winter an additional 400 to 500 moose migrate from Yellowstone and Grand Teton National Parks and surrounding National Forest lands to the riverbottoms. Winter densities along the Snake River from the Gros Ventre River junction north to the Yellowstone National Park boundary varies from 10-50 moose per square mile. Moose densities along the Snake River from South Park Bridge to Wilson Bridge averaged 43 moose, or 4.3 moose per mile of river (1982-89). From the Wilson Bridge north to the confluence of the Gros Ventre River, moose densities average approximately 25 moose, or 6 moose per mile along this reach of river.

Moose that winter in the project area inhabit the Fall Creek and Jackson Moose Herd Units (Figures 15 and 16). The Department's harvest, population objectives, and economic data for these herd units are outlined below:

Table 5. Fall Creek Moose Herd Unit Statistics, 1983-1987 Average and 1988 recommended objectives (Fralick 1989).

Herd Unit Statistics -	1983-1987 (Avg.) &	1988 (Proposed)
Population	159	170
Harvest	24	29
Hunters	27	30
Success	89%	96%
Recreation Days	146	189

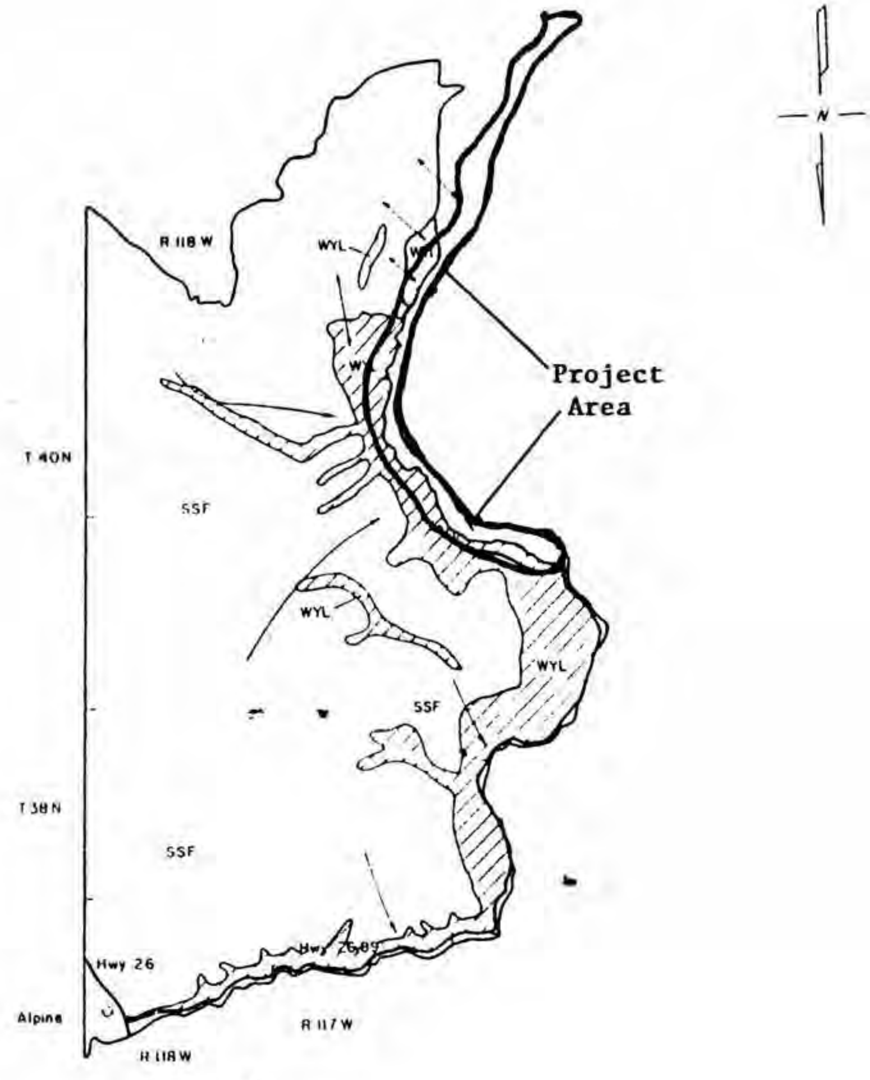
Dollars Entering State's Economy $15,848

Table 6. Jackson Moose Herd Unit Statistics, 1983-1987 Average and 1988 recommended objectives (Fralick 1989).

Herd Unit Statistics -	1983-1987 (Avg.) &	1988 (Proposed)
Population	1964	2350
Harvest	263	295
Hunters	369	347
Success	72%	85%
Recreation Days	2354	2360

Dollars Entering State's Economy $255,675

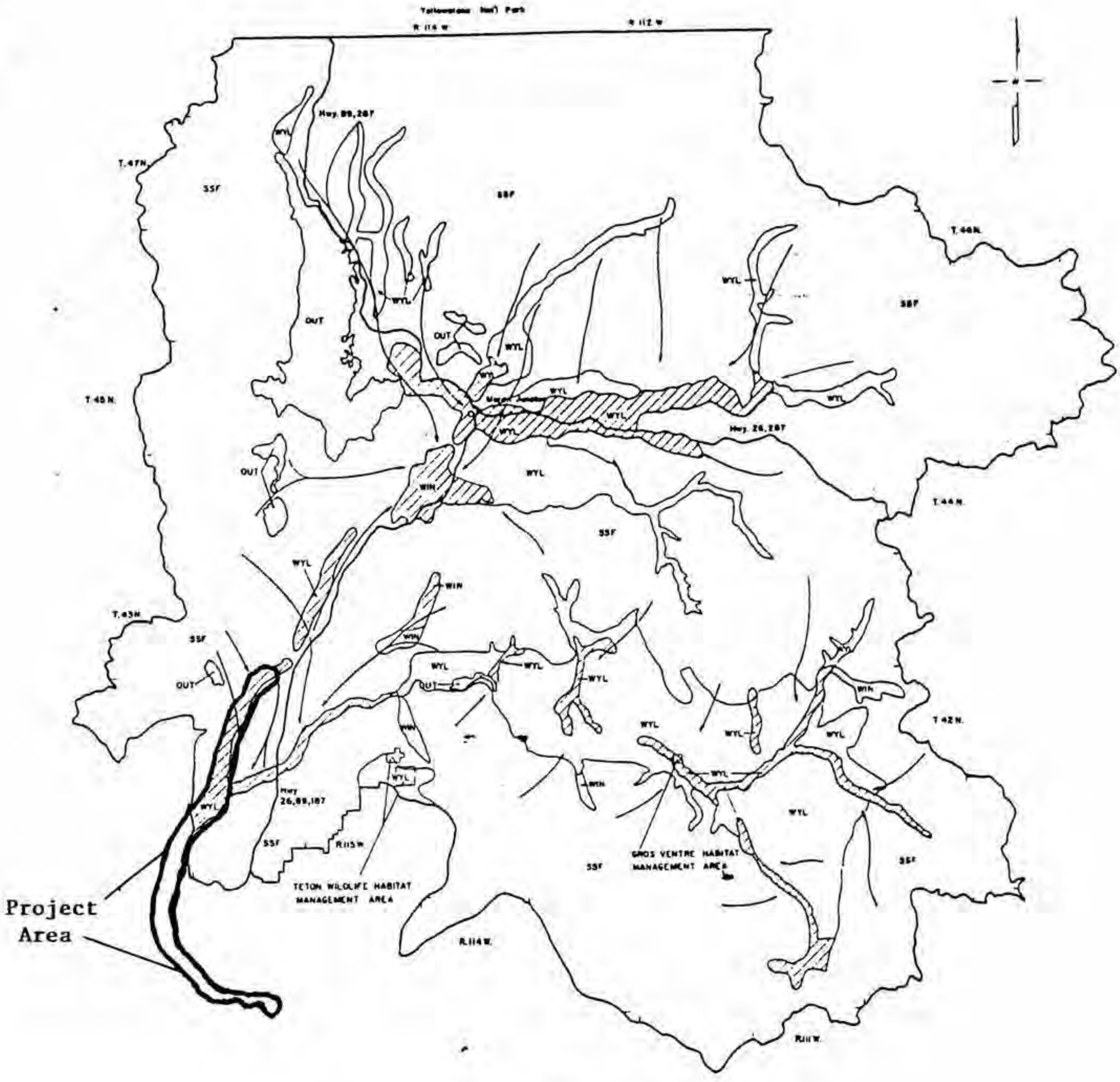
Deer: The study area north of the Wilson bridge is within the Jackson Deer Herd Unit (Figure 17). Crucial winter ranges for this herd are found to the east and south of the project area near West Gros Ventre Butte. Mule deer



LEGEND

(hatched)	-	Crucial Range
OUT	-	Habitat of Limited Use
→	-	Migration Routes
PAR	-	Parturition area
SSF	-	Spring thru Full Range
WIN	-	Winter Range
WYL	-	Winter/yearlong range

Figure 15. Seasonal range and distribution of the Fall Creek moose herd (WGFD 1988).



LEGEND

- (hatched symbol) - Crucial Range
- OUT - Habitat of Limited Use
- → - Migration Routes
- PAR - Parturition area
- SSF - Spring thru Full Range
- WIN - Winter Range
- WYL - Winter/yealong range

Figure 16. Seasonal range and distribution of the Jackson moose herd(WGFD 1988).

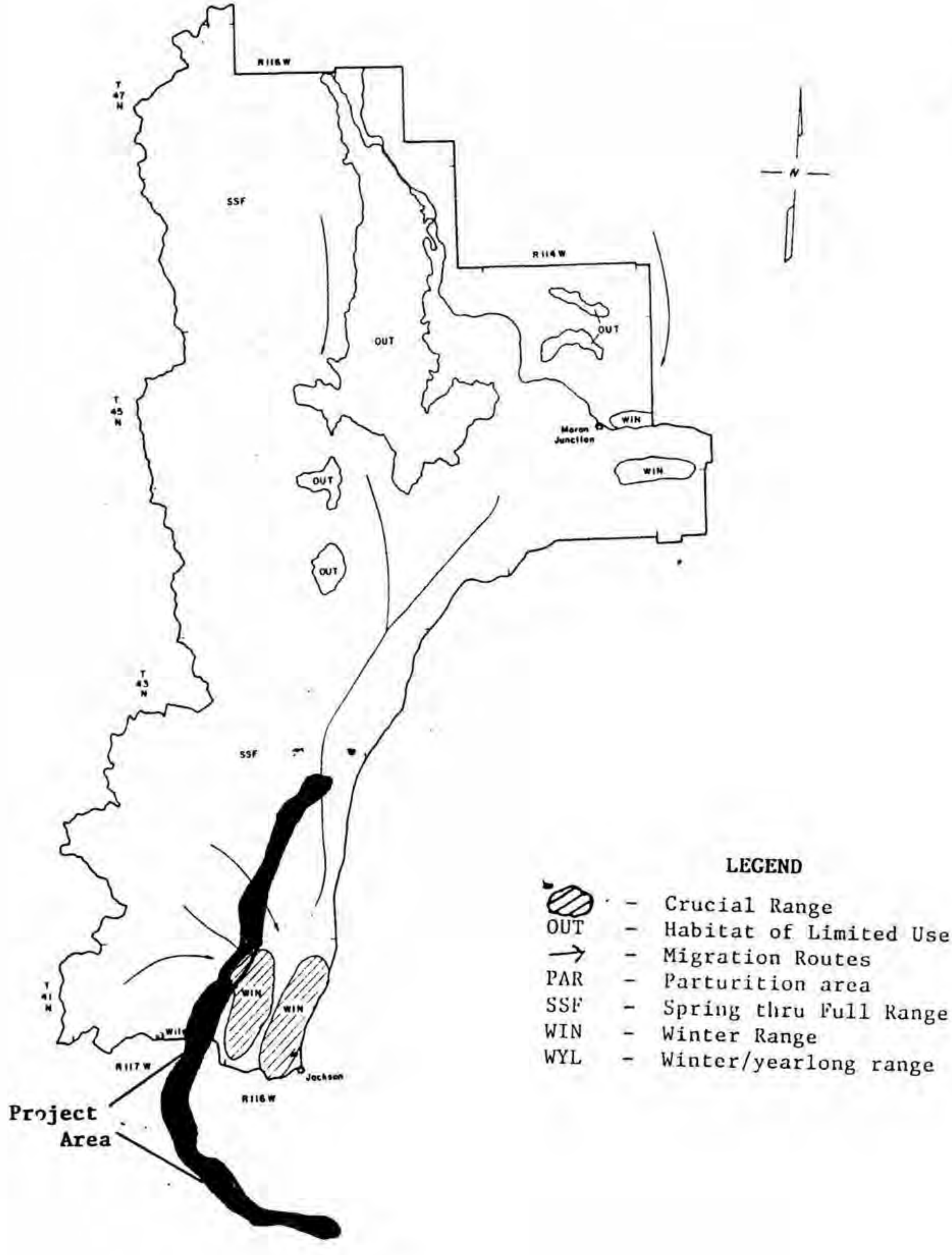


Figure 17. Seasonal range and distribution of the Jackson mule deer herd (WGFD 1988).

(Odocoileus hemionus hemionus) migration patterns exhibit an eastward movement through the project area to winter ranges on the east side of the Snake River. The southern portion of the levee project is located within the Sublette Mule Deer Herd Unit (Figure 18). Winter ranges for the northern segment of this herd unit are not inclusive to the project area, as most deer migrate through the area to winter ranges located to the east and in the Green River Basin. However, the South Park Habitat Unit provides winter range for approximately 100 deer within this herd's unit. Most of the mule deer use in the project area is from late spring through fall.

Small numbers of white-tailed deer (Odocoileus virginianus) have been observed in the Snake River drainage. During the winter of 1988-89, six white-tailed deer were observed on the South Park Habitat Unit. Typically, however, white-tailed deer are widely dispersed throughout the drainage and are considered to be very low in population numbers.

Antelope: Pronghorn antelope (Antilocapra americana americana) use the floodplain and sagebrush benches of the Upper Snake River drainage during the summer. Between 100-200 pronghorn of the Sublette Herd Unit summer in the valley after migrating from winter ranges in the Green River Basin. Within the project area, and specifically in the South Park area, there are approximately 10 pronghorn that have summered on the north segment of the South Park Habitat Unit since 1985. As winter approaches these pronghorn migrate out of the area to the desert regions of the Green River Basin.

Bison: The 1988-89 estimated wintering population of bison (Bison bison) in the Jackson herd was 137. This bison herd inhabits the National Elk Refuge during the winter and upland habitats of the Grand Teton National Park during spring, summer, and fall; therefore, this herd would not be affected by the activities associated with the levee project.

Bighorn Sheep: The two quarry sites proposed for development located east of the National Elk Refuge are within crucial bighorn sheep (Ovis canadensis canadensis) winter range (Figure 19). Approximately 40 to 50 sheep of the Jackson herd unit winter in the proposed Curtis Canyon quarry area. Another 50 sheep use the proposed Flat Creek Talus quarry site and adjacent area during the winter. The latter area is the most consistently lower elevation site used by area bighorns in the Jackson Hole area.

Endangered Species

The four endangered species that occur within the project area are the whooping crane (Grus americana), peregrine falcon, bald eagle and the grizzly bear (Ursus arctos horribilis). The grizzly bear and bald eagle are considered residents, and the whooping crane and peregrine falcon are present during spring, summer, and fall. According to Section 7(a)(2) of the Endangered Species Act of 1973, as amended, the Corps must insure its proposed Federal action does not jeopardize the continued existence of listed species or adversely modify critical habitat. Pursuant to 50 CFR 402.06 (b), Section 7 consultation may be consolidated with the interagency cooperation

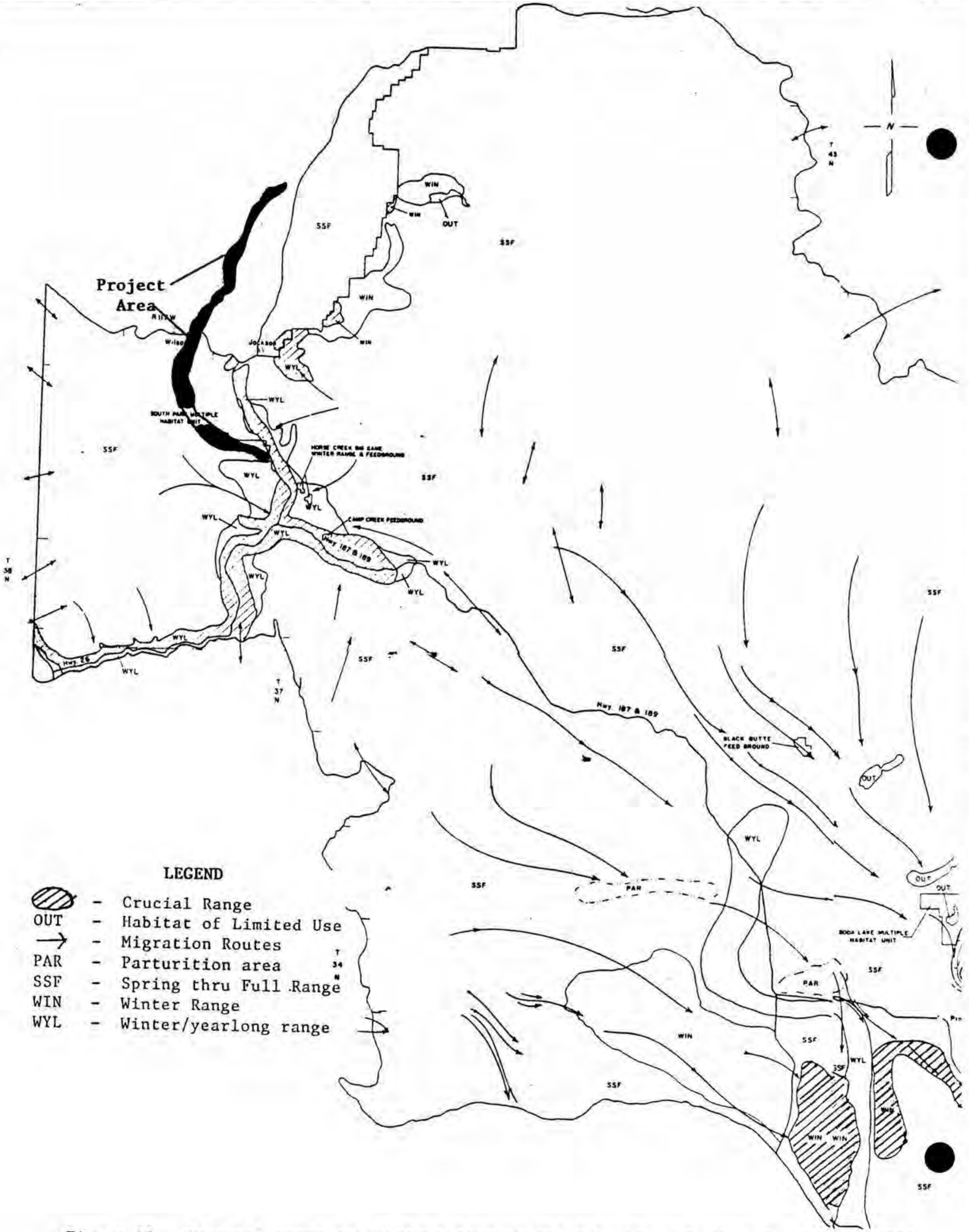


Figure 18. Seasonal range and distribution of the Sublette mule deer herd(WGFD 1988).

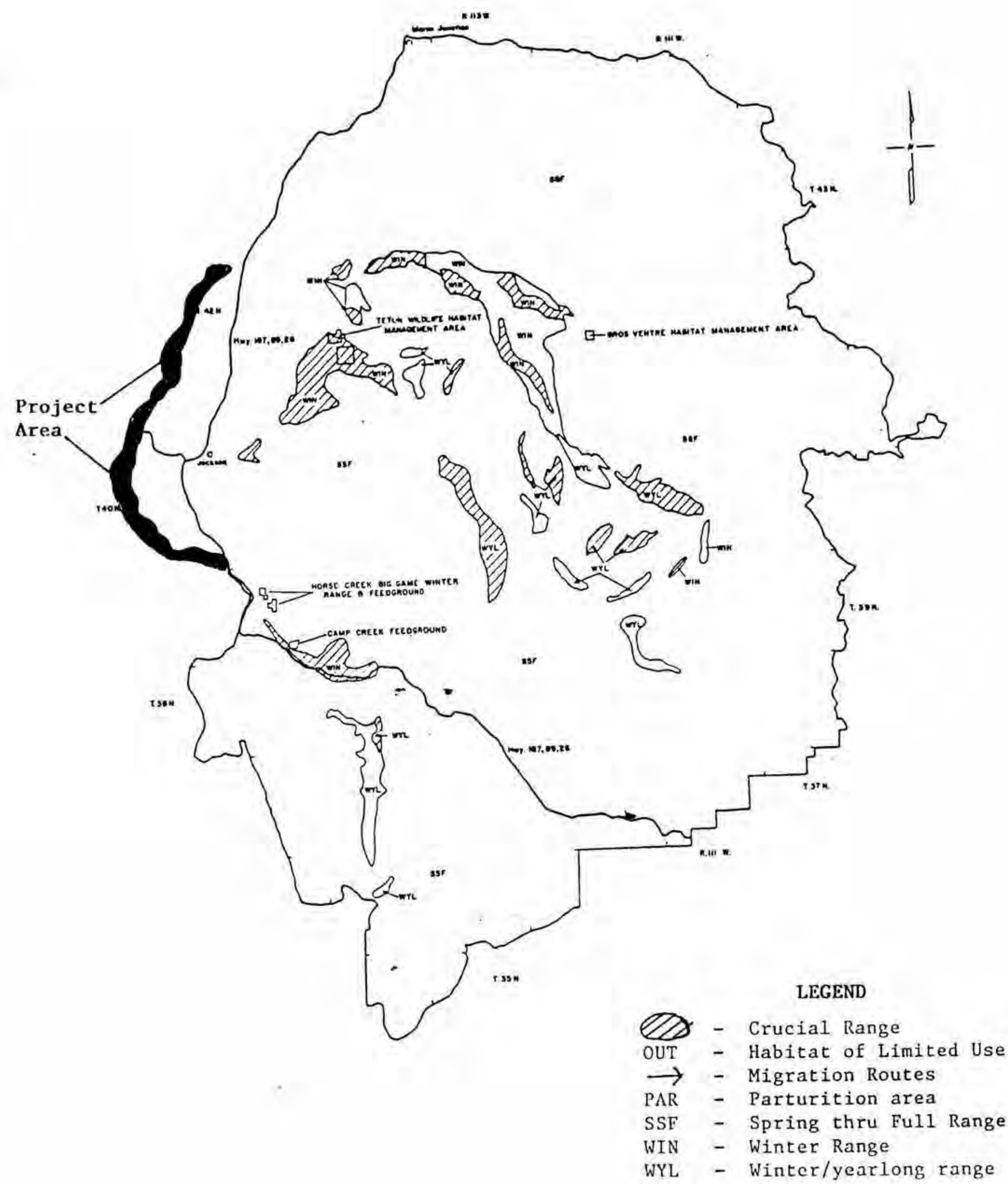


Figure 19. Seasonal range distribution of the Jackson bighorn sheep herd (WGFD 1988).

procedures required by the National Environmental Policy Act or Fish and Wildlife Coordination Act.

Bald Eagles

In 1988, 63 pairs of bald eagles attempted to nest in the Greater Yellowstone Ecosystem (GYE). The GYE population is considered to be one of the most significant populations in the Rocky Mountain west (Swenson et al. 1986). Although the GYE bald eagle population appeared severely threatened with extirpation prior to the 1970's, it has increased from a low of 30 pairs to its current level. Swenson et al. (1986) predicted the ecological carrying capacity of the GYE at 108 pairs, based on population growth rates between 1970 and 1982. Management objectives of the GYE call for 62 nesting territories with approximately 53 pairs that attempt to nest annually (GYE Bald Eagle Working Team 1983, U.S. Fish and Wildlife Service 1986).

Ecological evaluations and management of GYE bald eagles have focused on three units within the population: the Snake, Yellowstone and Continental Units (Figure 20). The Snake Unit, and especially the Wyoming portion, was historically significant in providing habitat and conditions suitable for the remnant population essential to the current trend of recovery (GYE Bald Eagle Working Team 1983).

There are 6 nesting territories in the reach of river between Moose and the South Park Bridge. Since 1982, these 6 pairs (28.6 percent of the Snake Unit, Wyoming portion of the GYE population) have produced 50 young or 41 percent of the total production (1982-88). These 6 pairs averaged 1.47 young per nesting attempt, which is considered excellent production and of historical significance in providing breeding adults for the recovering GYE population (Swenson et al. 1986).

The general locations of nest sites are presented in Figure 21. One pair nests north of the levee system, one pair near the confluence of the Gros Ventre River and 4 pairs nest at the southern end of the project area. Nests are strongly oriented towards areas of the river that are not tightly restricted by levees. For example, along the 10 miles of river that is tightly restricted by levees, not one nest site has been established.

In general, bald eagles seem to choose nest sites in trees larger than surrounding trees. In the Snake Unit, the height of nest trees averaged 16.7 meters with an average diameter breast height of 85.3 centimeters. Swenson et al. (1986) noted that bald eagles did not have rigid requirements for nest trees, but selected the most desirable tree or stand of trees closest to a reliable food source available early in the nesting season. Human disturbance is known to affect nest tree selection (Harmata 1989 and Swenson et al. 1986).

Harmata (1989) found nesting chronology (Table 7) similar to chronology previously estimated for the same area by Swenson et al. (1986). Courtship and nest repair may begin as early as late February. Egg laying occurs in March and fledgling occurs during July. Young are closely associated with the adult pair and nesting territory from fledgling through September.

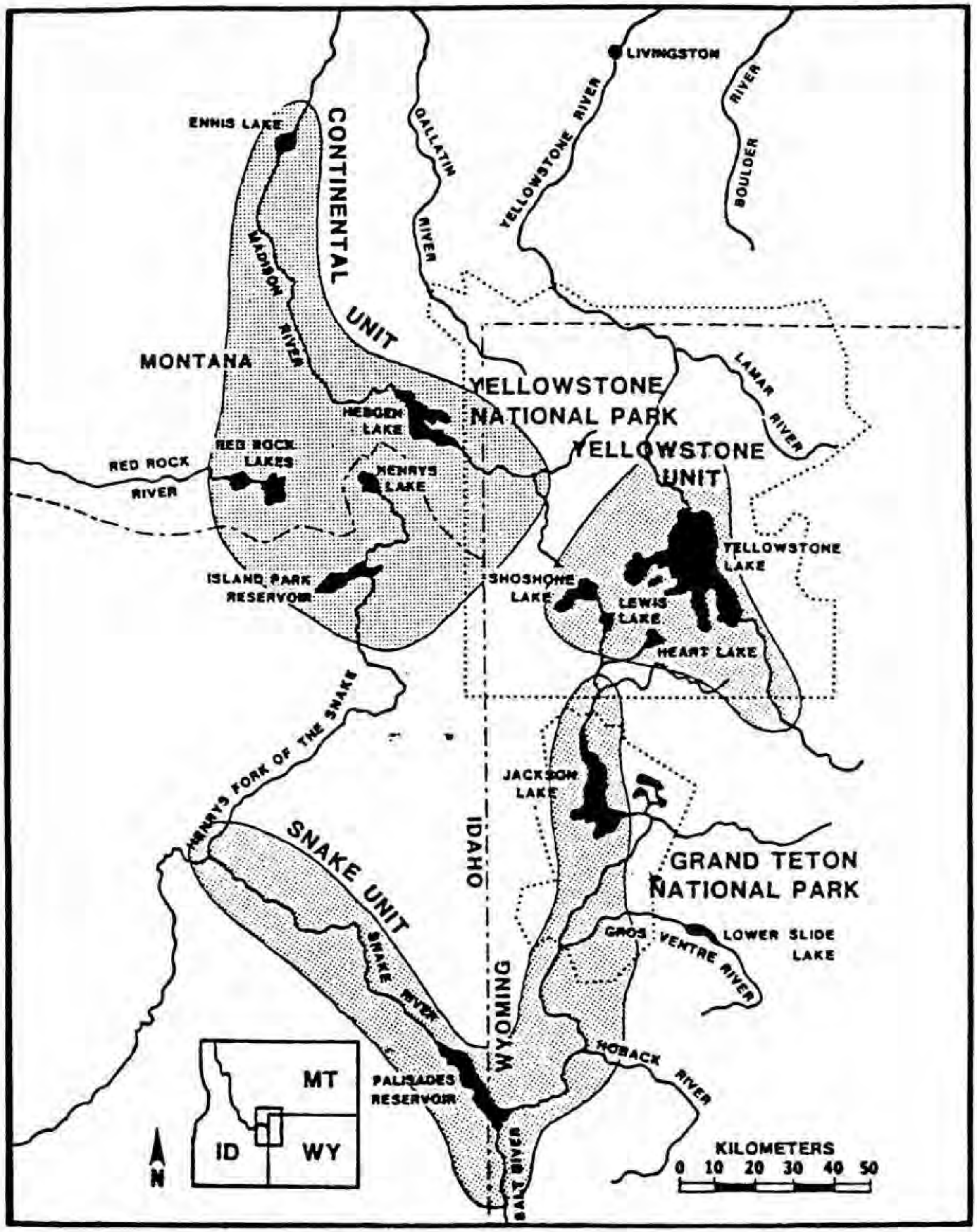


Figure 20 A map of the Greater Yellowstone Ecosystem showing three bald eagle population units (stippled) (adapted from Swenson et al. 1986).

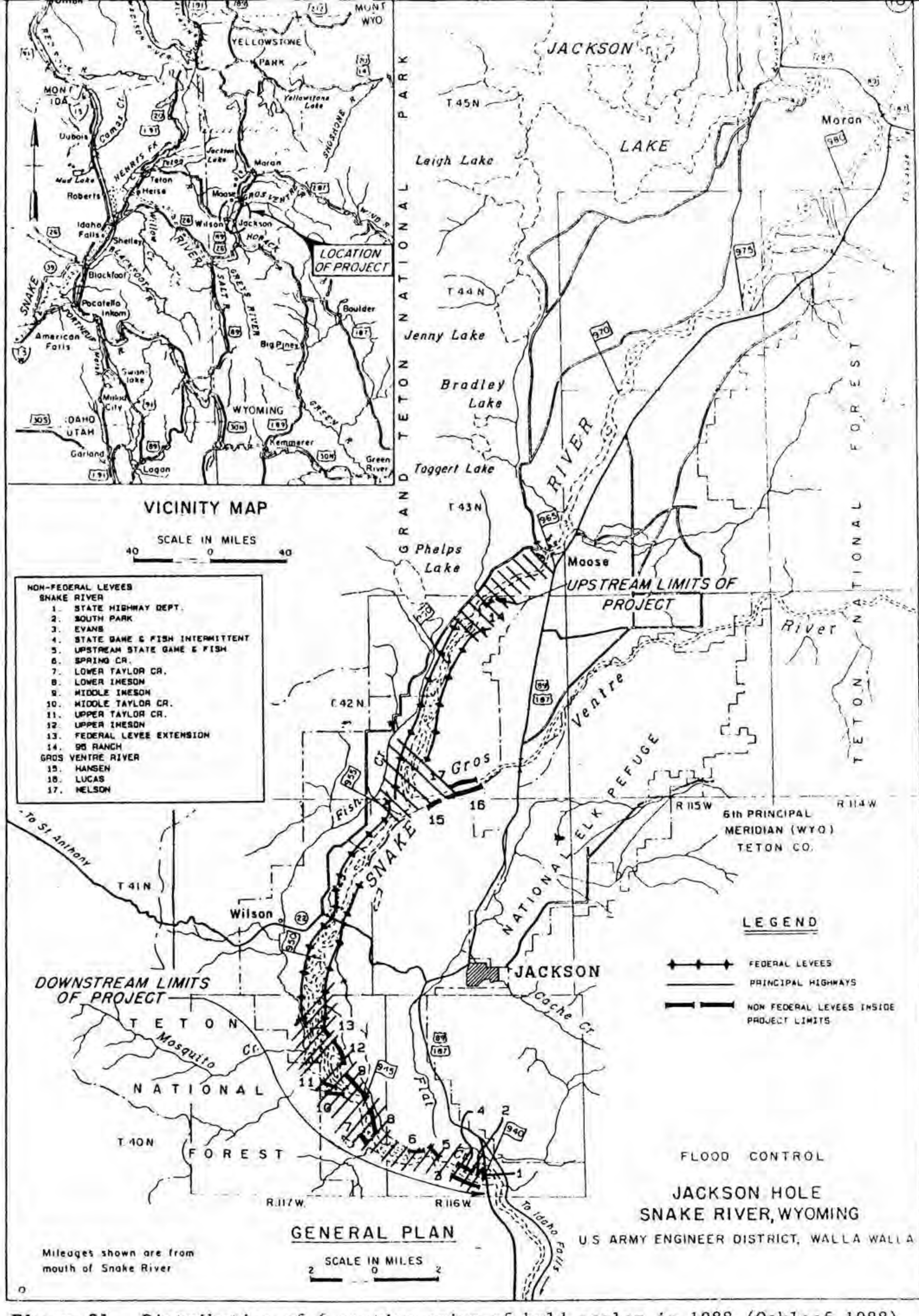


Figure 21. Distribution of 6 nesting pairs of bald eagles in 1988 (Oakleaf 1988). Cross hatch areas identify nesting locations.

Harmata (1989) described the movement of young and subadults produced along the Snake River. Adults remain loosely associated with the nesting areas throughout the fall and winter. Winter bald eagle use within the area (Figure 22) appears to be primarily by resident adults and an influx of a small number of migratory adults and subadults.

Table 7 BALD EAGLE NESTING CHRONOLOGY (1985-1988), WYOMING PORTION OF THE SNAKE UNIT.

NESTING ACTIVITY	OBSERVED INITIATION DATE AVERAGE	RANGE	SAMPLE SIZE
Incubation	March 18	March 3 - April 23	23
Brooding Young	May 1	April 9 - May 25	22
Fledgling	July 14	June 6 - August 17	18

Bald eagles consume a variety of prey items including ungulate carrion, waterfowl and fish (Swenson et al. 1986). Use of these food items are probably related to their abundance and availability during a given time of the year. Ungulate carrion is primarily important during the months of December through March when other prey groups are not as readily available. Early in the breeding season, eagles feed largely on cutthroat trout that are spawning in area spring creeks. Waterfowl provide an early spring prey source and may also be important in late June and July when molting waterfowl become available. The abundance of waterfowl may also compensate for reduced availability of fish during spring runoff as a result of high velocities and turbid conditions associated with the river during this period.

Although bald eagle food habits may vary during the season, over 60 percent of their diet consists of fish (Harmata 1989 and Swenson et al. 1986). Fish become especially important during the nesting season. The availability of fish is dependent on the physical structure of the river, behavior patterns of the different fish species, and level of human disturbance. Due to habitat preferences, season of use and spawning characteristics, different species are more available at different times of the year. Cutthroat trout spawners in the shallow spring-fed tributaries provide food during high run-off periods when foraging on the main river is typically difficult.

Peregrine Falcon

Peregrine falcon reintroduction efforts in the Jackson area were initiated in 1980 by the Peregrine Fund Inc. and have been cooperatively funded through Endangered Species Act/Section 6, Forest Service, Park Service, Bureau of Land Management and Department monies. Prior to these efforts, a viable breeding population did not exist in the area. Plans to reestablish a nesting population of birds were developed from analysis of historical distribution and evaluation of potential habitat. The goal of the

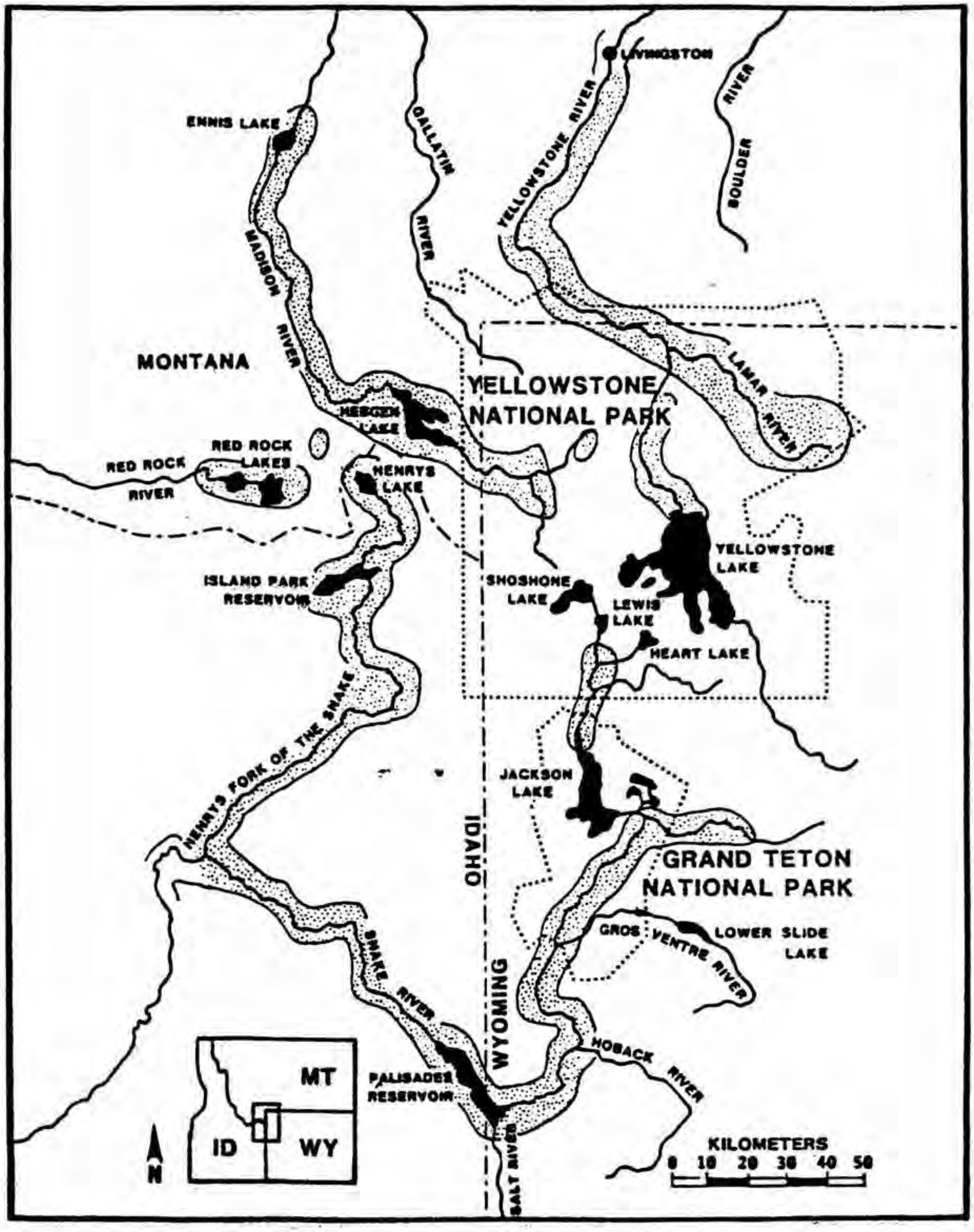


Figure 22 A map showing bald eagle wintering areas (stippled) within and adjacent to the breeding range of the Greater Yellowstone Ecosystem bald eagle population (adapted from Swenson et al. 1986).

reintroduction program is to establish and maintain a self-sustaining breeding population in the wild. The objectives are to annually release approximately 15 peregrines and establish 10 breeding pairs in northwest Wyoming and 14 pairs throughout the state. Wyoming's program has been closely coordinated with Idaho and Montana to facilitate the reestablishment of a viable population within the GYE.

Results of peregrine releases are presented in Tables 8 and 9. Since 1980, a total of 184 peregrines have been released. At least 150 of these falcons were known to have survived the first month following fledgling. These birds began killing prey regularly on their own and dispersed normally. In addition, adjacent releases in Idaho and Montana have added 164 falcons (1981-87) to the coordinated efforts in reestablishing a breeding population in the GYE.

Observations of returning peregrines in the release area are encouraging. In 1984, a pair nested at an historical eyrie not occupied since 1969. A total of 11 pairs were documented in the tri-state recovery area in 1988 (Montana, Idaho, Wyoming). Of these, 6 pairs were documented in the Wyoming release area and produced 10 young (Levine 1988). In 1989, there were 11 young produced at 12 wild eyrie sites within the recovery area, and a total of 30 birds were released at hack sites of which 23 successfully fledged.

Two of the release sites are located near the project area (northwest of Wilson and on the National Elk Refuge) and have been used since 1981 and 1983, respectively. Between 1981 and 1988, 75 peregrines have been released from these 2 sites. Fifty-six (75 percent) of these falcons have survived to dispersal age. Although returning adults have been observed at both release sites, the hack sites are located away from potential nesting cliffs so that adults will not establish nesting territories and preclude the future use of these sites for release of falcons. The nearest known nesting occurs in Grand Teton National Park. Observations of adults indicate that nesting territories may be established in the future on the National Elk Refuge and in the south end of the Jackson Valley; however, no eyries have been documented to date. Numerous observations indicate that the project area currently provides foraging habitat for migrating and nonbreeding subadult peregrines.

Peregrine falcon nesting sites are generally cliff areas within mountain valleys and river gorges. An adequate food source (primarily small to medium-sized terrestrial birds, shorebirds and waterfowl) is normally found within ten miles of the nest sites. Important hunting areas are wetland and riparian habitats, meadows, parklands, canyons and lakes. Peregrines in the recovery area have been observed utilizing over 25 species of birds as prey.

A general analysis of peregrine nest site selection in the recovery area indicates that the distribution is influenced by early season prey abundance(Levine 1988). Nest site selection and egg laying occurs in April. Potential prey species available in April are primarily restricted to conifer forests, canyons and early season wetlands. Since prey abundance is typically limited in conifer forests during April, wetlands that thaw early

Table **8** Reintroduction of peregrine falcons in the Rocky Mountain states in 1985-86 (adapted from Heinrich 1985, 1986).

State	Year	# of Birds Released	# of Successful Birds	Percent of Birds Reaching Independence
Wyoming	1985	30	25	83
	1986	25	20	80
	1987	25	20	80
Montana	1985	25	22	88
	1986	23	18	78
	1987	23	18	78
Idaho	1985	20	15	75
	1986	18	13	72
	1987	18	14	78

Table **9** Peregrine falcon recovery program (from Heinrich 1987).

		Total Released		Pairs Known				
State	Year	Attp.	Succ.	1975	1987	1987 Prod. Pairs	Recovery Goal	Estimated Completion Peregrine Release
Wyo.	80-87	137	113	0	4	2	14	1995
Mont.	81-87	93	81	0	3	1	20	1995
Ida.	77-79 82-87	92	67	0	1	0	17	1995

appear to be essential components of peregrine falcon nesting habitat. Later in the nesting season, prey is available in a variety of habitats.

Whooping Crane

Whooping cranes occupying western Wyoming habitats have resulted from the reintroduction efforts at Gray's Lake National Wildlife Refuge in Idaho. Whooping cranes from the Gray's Lake flock have occupied Wyoming since 1977. Their range coincides with those of the sandhill crane. In the summer of 1985, there were 26 to 31 whooping cranes in the population of which 10 stayed in Wyoming. Since 1977, an average of 34 percent of these cranes annually summer in Wyoming (Table 10). In 1988, only 16 whoopers from the Gray's Lake flock were still alive.

Major upland and wetland habitats used by cranes include: 1) wetland types with deciduous shrubs and low emergents that are seasonal and temporary flooded; 2) wetland types with tall emergents, open water marshes, riverine/beaver ponds, oxbows and sandbars that are permanent and semi-permanent flooded; 3) upland types with upland deciduous trees or upland conifer edge, sage/grass, upland grass/forb meadow, irrigated hayland and small grains.

The occurrence of whooping cranes in Wyoming has been divided into three general periods: 1) spring migration (April 1 - May 15); 2) summer residency (May 16 -August 20); 3) fall pre-migration staging (August 21 - September 25). Whooping cranes have been observed during the spring months in the riverbottom areas along the Snake River and Spring Creeks (Lockman et al. 1985). In 1987, a yearling whooping crane summered in the project area near the headwaters of Spring Creek south of the Wilson Bridge. In 1988, a whooper summered along the Snake River north of Moose. Typically, native hay meadows are used as feeding, loafing, and roosting areas. When whooping cranes are observed in Wyoming, they are usually associated with sandhill cranes and, as such, the habitat use and distribution of these two species of cranes frequently coincides with one another.

Food items of importance to both whooping and sandhill cranes in Wyoming include: timothy corymbs, tubers, annelids, mollusks and crustaceans, insects, mice, voles, amphibians, grains, alfalfa sprouts and germinating seeds.

Grizzly Bear

The project area lies approximately 2 miles outside of the grizzly bear recovery zone. Therefore, grizzly bear survival and recovery should not be impacted by activities associated with the levee project. However, given the close proximity of the Yellowstone Grizzly Bear Ecosystem (U.S. Fish and Wildlife Service 1979), it is possible that grizzly bears may occur within the project area, although no recently documented grizzly bears observations have been reported.

In general, riparian sites are important for foraging, traveling and as bedding areas for bears. Grizzlies forage on succulent vegetation associated

TABLE 10 WHOOPING CRANE NUMBERS RESULTANT FROM THE GRAYS LAKE REINTRODUCTION PROGRAM (Oakleaf 1989).

YEAR	POPULATION SIZE (SUMMER)	NUMBER IN WYOMING (SUMMER)	PERCENT IN WYOMING
1976	3	-	-
1977	6	1	16.7
1978	6	2	33.3
1979	8	3	37.5
1980	15	4	26.7
1981	13	5	38.5
1982	10	4	40.0
1983	13	5	38.5
1984	21	6	28.6
1985	26	10	38.5
1986	28	7	25.0
1987	21	8	38.1
1988	16	7	43.8

with riparian sites in the spring. Movements of grizzly bears from den sites to riparian foraging sites in the spring may place them in vulnerable proximity to human activities. In early summer, grizzlies in the Yellowstone Ecosystem will feed on cutthroat trout in spawning streams. Throughout the summer grizzlies frequent high elevation areas feeding on nuts, roots and berries. Riparian sites are used as travel corridors by bears between summer habitats. In the fall, grizzlies will prey on vulnerable ungulates and/or scavenge on ungulate carrion or offal along riverbottoms. This may again bring bears into close proximity to humans, potentially leading to conflicts and bear mortalities. Therefore, providing adequate cover and seclusion for grizzly bears is important to permit optimal use of habitat components during the different seasons.

Amphibians and Reptiles

Herptiles play an important role in many ecosystems. Many species feed on insect populations and, subsequently, represent a food source for various mammals, birds and fish. Of the forty-two varieties of amphibians and reptiles identified in Wyoming, only a few are of direct economic importance, however, aesthetic values are gained from their colorful appearance and calls (Baxter and Stone 1980). A few species of note with geographic ranges overlapping the project area include: tiger salamander (Ambystoma tigrinun), northern leopard frog (Rana pipiens), spotted frog (Rana pretiosa), boreal chorus frog (Pseudacris triseriata maculata), rubber boa (Charina bottae), bullsnake (Pitophis melanoleucas sayi), wandering garter snake(Thamnophis elegans vagrans) and valley garter snake (Thamnophis sirtalis fitchi).

Recreational Use

Recreational use has paralleled the upward visitation trend within the Jackson Hole Valley area. Yearlong distribution of visitors and recreational pursuits have changed from seasonal to year-round activity. Primary attractions include Yellowstone and Grand Teton National Parks, Teton and Bridger Wilderness Areas, the Bridger-Teton National Forest, the National Elk Refuge, and major water bodies both in and outside of these land units. Popular recreational activities include fishing, hunting, hiking, power boating, river floating, wildlife viewing, skiing, horseback riding, and simply sightseeing. Over 200 outfitters and guides offer services for day and overnight trips. Numerous public campgrounds are available for recreational use throughout the area (U.S. Forest Service 1988).

Key recreational pursuits in the project area are river floating, fishing, wildlife observation, hiking and cross country skiing. Access to the river within the project area is limited, primarily occurring around the Wilson Bridge and the South Park Bridge. Consequently, much of the river recreation within the project area is accomplished by floating downstream.

River floating on the Snake River is composed of two primary components in the Jackson Hole area. Most visitors take either scenic floats on the calmer reaches of the Snake through Grand Teton National Park and the Jackson Hole

Valley or whitewater floats through the "Grand Canyon of the Snake River" below Hoback Junction. Commercial and non-commercial users also float the Moose-Wilson and/or Wilson-South Park reaches. According to Forest Service and Park Service records, nearly 200,000 days of floating activity occurred in the Jackson Hole area in 1985 (Phillips 1987). The total river floating activity between Moose and South Park is probably between 10,000 to 15,000 visits per year (U.S. Army Corps of Engineers 1989). This level of use is approximately 5 to 8 percent of the total Snake River floating activity.

Trout fishing is clearly an important recreational activity in Jackson Hole, and the Snake River is probably the single most significant fishing resource. The area provided 288,597 days of fishing recreation in 1985 (Phillips 1987). Of this total, 179,735 days are attributed to resident anglers and 108,812 days to non-resident anglers. Local residents accounted for approximately 65,000 days of angling effort. Results of a 1985 survey by Phillips indicated that 93 out of 340 parties interviewed had fished during their stay in the Jackson Hole area. These fishing parties had spent an average of $448 during their stay, which was $61 higher than the average for the entire sample. The average expenditure per person was $30.64 a day. This amounts to a $6.8 million boost to the local economy. This, plus the estimated $6 to 7 million expenditure by river floaters, suggests that water based recreation activities in the area account for 15 to 20 percent of the tourism/recreation expenditures.

Data on total number of anglers and cutthroat trout harvested from 1970 to 1985 along the Snake River between Jackson Lake and Palisades Reservoir by river reach (Figure 23) are in Figures 24 and 25 and Table 11. Data on activity and harvest levels in 1985 for the river reach within the project area accounted for about 6,700 angler visits or 48% of the total from Jackson Lake Dam to Palisades (U.S. Fish and Wildlife Service 1987).

For comparison purposes, the National Park Service reported angling activity levels in Grand Teton National Park of over 64,000 visits in 1980 (U.S. Department of Interior 1984) and over 92,000 visits in 1988 (Bernard 1989). The 1980 figures included nearly 35,000 people fishing from boats on Jackson Lake, 13,900 bank anglers at Jackson Lake, and 12,000 bank anglers directly below Jackson Dam.

According to Department estimates, more than 75 percent of the annual waterfowl hunter recreation in the Snake River drainage occurs on private land along the Snake River (Fralick 1989). About 1,500 goose and 2,400 duck hunter recreation days are expended annually (1980-1986) along the river (Lockman 1986). The Department's South Park Unit is one of the most popular waterfowl hunting locations within the project area.

Annually, approximately 8 trappers worked traps on the Snake River from the South Park area north to the Grand Teton National Park boundary for beaver and muskrat. If the success of the 8 trappers was the same as the state averages for years 1983-87, they collectively spent 227 days/year to harvest 127 beavers and 238 days/year to harvest 218 muskrats.

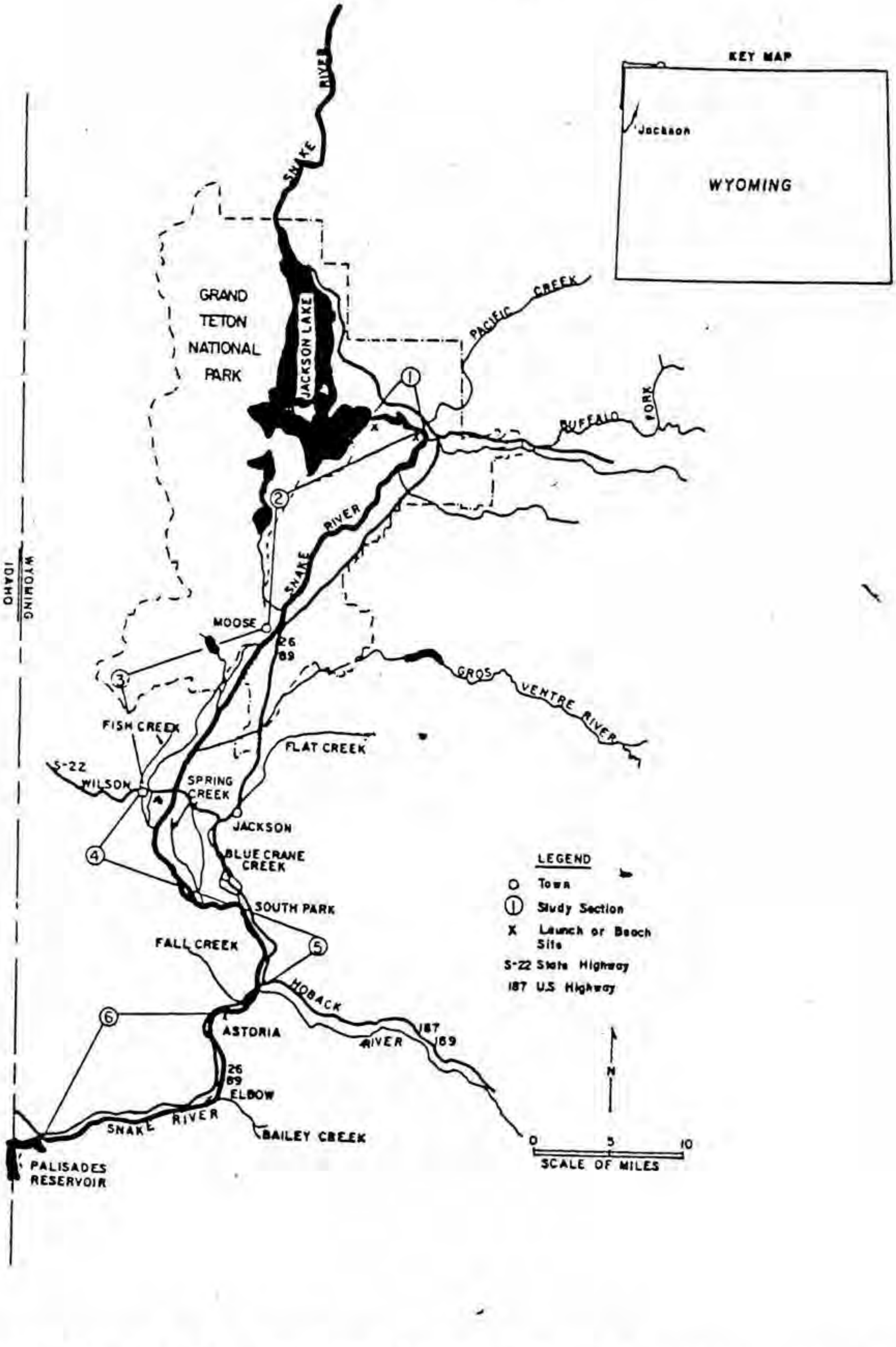


Figure 23. A map of the Snake River depicting the study sections (provided by Jon Erickson and John Kiefling, Wyo. Dept. of Game and Fish, Jackson, Wyoming).

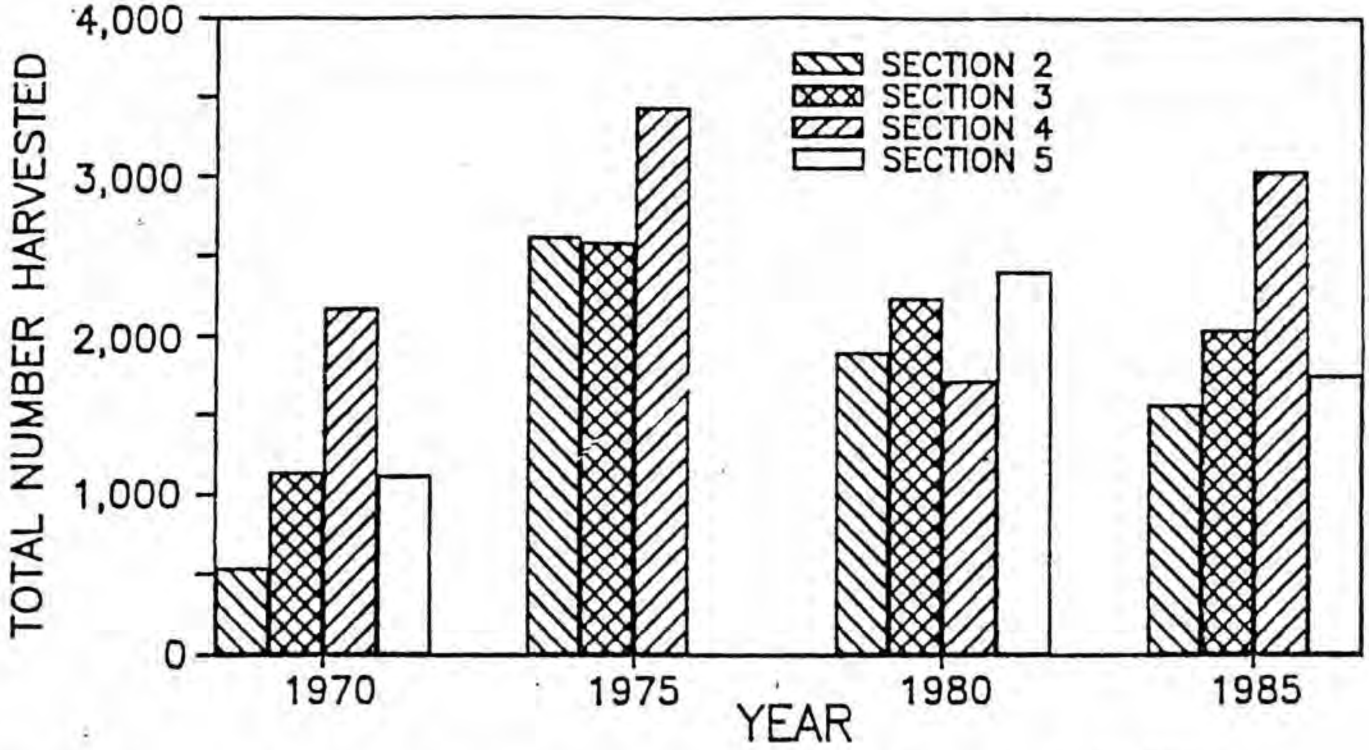
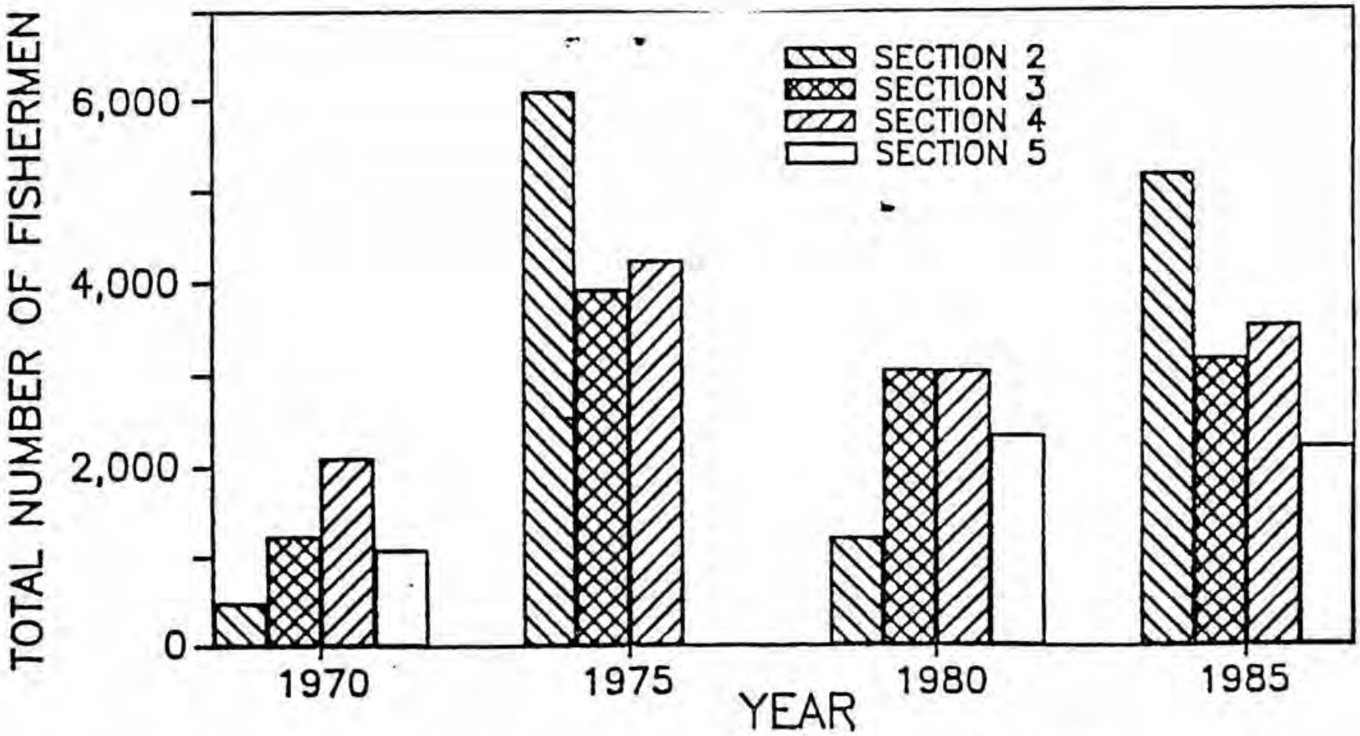


Figure 24. Total number of cutthroat trout harvested along the Snake River from 1970 to 1985 (Data provided by Jon Erickson and John Kiefling, WGFD, Jackson, Wyoming).



- Figure 25. Total number of fishermen along the Snake River from 1970 to 1985 (Data provided by Jon Erickson and John Kiefling, WGFD, Jackson, Wyoming).

Table 11. Total number of fishermen, number of cutthroat trout harvested, harvest rates (fish caught per unit effort or hour), and catch rates (fish caught and released plus those harvested per unit effort), for study sections of the Snake River from 1970 to 1985 (Data provided by Jon Erickson and John Kiefling, WGFD, Jackson, Wyoming).

Year	Sec.	Total Fishermen	Cutthroat Trout Harvest	Harvest Rate			Catch Rate		
				Bank	Boat	Combined	Bank	Boat	Combined
1970	2	487	540	0.25	0.34	0.31			
	3	1,245	1,143	0.21	0.49	0.37			
	1	2,109	2,174	0.20	0.47	0.35			
	5	1,094	1,122	0.46	0.39	0.41			
Total		4,935	4,979						
1975	2	6,092	2,618	0.15	0.09	0.12	0.42	0.80	0.61
	3	3,923	2,583	0.23	0.33	0.28	0.46	0.62	0.54
	4	4,237	3,436	0.32	0.38	0.35	0.54	1.06	0.80
Total		14,252	8,637						
1980	2	1,219	1,899	0.15	0.12	0.13	0.73	1.05	0.95
	3	3,054	2,242	0.24	0.26	0.25	0.62	0.90	0.76
	4	3,052	1,716	0.14	0.17	0.16	0.47	0.97	0.72
	5	2,346	2,408	0.52	0.36	0.44	1.33	1.32	1.33
Total		9,671	8,265						
1985	2	5,177	1,561	0.11	0.08		0.65	0.91	
	3	3,177	2,042	0.13	0.23		0.58	1.34	
	4	3,536	3,031	0.08	0.26		0.49	1.23	
	5	2,216	1,752	0.29	0.29		0.65	1.01	
Total		14,106	8,386						

Traditionally, Jackson Hole valley has received fairly heavy big game hunting pressure. In recent years, with residential development of the floodplain, pressure has significantly decreased hunting opportunities. In order to reduce safety hazards to homeowners, the area north of the Wilson Bridge has been changed to archery hunting only. Hunting is allowed within the Department's South Park Habitat Unit; however, the greatest recreational value of the unit is derived from the hunting opportunities provided by the big game animals that winter there. From 1983-87, an average of 926 hunters spent 3,076 days to harvest 140 elk that winter on the South Park Habitat Unit. During this same period, the harvest success for these hunters averaged 5.2 percent. Elk hunters expended, on the average, $321,486 during this 5-year period. This amounts to a total of $2,296 spent for each elk harvested that winters on the South Park Unit.

The South Park Unit is also used in a nonconsumptive capacity during periods outside the hunting season. The Department's consumptive and nonconsumptive use objectives for the South Park Habitat Unit are provided below:

1. Nonconsumptive Use - provide 12,000 man-days of quality nonconsumptive use (to include such activities as photographing, hiking, rifle target practice, wildlife observation, and studies).

2. Consumptive Use - provide 800-1,000 man-days of fishing on Flat Creek (currently Flat Creek provides 600 fisherman days per year on the unit).

The close proximity of the habitat unit to the city of Jackson provides residents and tourists a varied number of outdoor activities each year. Hiking, picnicking, and other outdoor activities are very important and popular uses of the South Park Habitat Unit. To document the extent of public use of the South Park area, a traffic counter was used by the Department from 1970-1976. During this period, from June 1 through September 10, the number of vehicles averaged 3,641 per month (Fralick 1989). This count includes all forms of recreation except hunting. From September 11 through November 16, the number of vehicles averaged 15,102 per month and encompassed all recreational uses, both consumptive and nonconsumptive. In addition, a small rifle range located on the unit receives a significant amount of use not documented by traffic counters. During 1988 an estimated 5,000 man-days of nonconsumptive use occurred on the South Park unit largely in the form of picnickers, overnight campers, and wildlife observation. It is believed that the Wilson Bridge area received similar nonconsumptive use.

DISCUSSION OF FISH AND WILDLIFE IMPACTS COMMONLY ASSOCIATED WITH THE LEVEE PROJECT ALTERNATIVES

The Snake River is a dynamic system! Under pristine conditions the river channel shifted its course laterally across the floodplain seeking a "natural" equilibrium. In recent years, however, the dynamics of the river have been interrupted because of man-made alterations. Some of these alterations include construction of levees, dams, and irrigation diversions.

Floods played an integral role in this dynamic floodplain process. Evidence today indicates flooding not only makes floodplain habitat seasonally available to aquatic organisms, but is also important: 1) for maintaining natural channel morphology, 2) as a mechanism whereby primary energy and nutrients are transported from upland and floodplain sources to wetland and aquatic communities, 3) as a controlling factor in floodplain plant succession, and 4) as a nutrient cycling mechanism that enhances productivity of floodplain vegetation (Hesse 1989). The following section summarizes the possible effects of the levee system on fish and wildlife resources that are expected to occur as the result of reduction in flooding and other impacts associated with the project.

Aquatic Resources

Spawning and nursery habitat for cutthroat trout, and possible overwintering habitat is a limiting factor in the upper Snake River drainage. Little or no spawning and nursery habitat exists in the main river particularly during spring run-off due to high flows and velocities, large sediment bed load movement, and turbid conditions. Historically, trout populations in the main channel portion of the river have been supported almost entirely by recruitment from the many spring creeks which feed the river. The trout are attracted to these spring-fed streams because of the cold water temperatures and quality spawning gravel (Kiefing 1978, 1981, 1984, Simpson and Wallace 1982). Habitat losses due to human activities (i.e. diversions for irrigation and levee construction) have also contributed to the now limited extent of spawning habitat.

Prior to construction of the levees, the spring creek system provided Snake River cutthroat trout with abundant spawning gravel and a variety of pool habitat and related cover. Flood waters flowing from the Snake River through high water channels maintained the integrity of these systems by flushing and recharging these creeks with new spawning gravel.

After construction of the levee system, spawning habitat in many of the spring tributaries began to gradually degrade as a consequence of restricting the flow of the river to a channelized area. The decreased capacity for high flows to flush sediments from spawning gravel in combination with increased sediment from agriculture and natural sources caused a steady decline in the suitability of spawning areas and reduced fish movement into these areas. Silt deposition, has enhanced growing conditions for vascular aquatic vegetation. This in combination with riparian vegetation encroachment, as a result of decreased flushing flows, has reduced habitat for all life stages of trout and for fish passage.

To mitigate the impacts caused by the levees, the Department has implemented several projects to restore spawning habitat and fish passage in some of the spring creeks within the project area. Except for Little Bar BC Spring Creek, this work has increased the number of spawning fish from two to three times the numbers of fish observed prior to habitat improvement. The number of spawning fish found in Little Bar BC Spring Creek at the present time is a 100 percent increase over previous levee conditions. Summaries of the present status of these fisheries are found on Page 13.

The levee system has significantly reduced the extent of side channels and the availability of rearing habitat for cutthroat trout and other fish. These areas are extremely important refuges for fish during high flows when velocities and streambed scouring and movement make the main channel a very harsh environment for most aquatic life. Wiley (1969) surveyed 12 miles of the Federal levee system and determined that 8 miles of permanent side channels were dewatered by levee construction and the remaining four miles of river bottom would probably have been subject to meandering prior to diking. During the 1970's significant amount of side channel habitat was also eliminated by non-Federal levee construction in the South Park area of the project.

The long-term effects of levee maintenance will eventually result in a significant loss of forested islands and narrowleaf cottonwood trees along the river, which are a source of snags or debris and bank cover used by trout. In addition, fallen trees and debris in the river channel will be subject to removal during annual O&M. Woody debris is important as habitat and cover for fish (Bilby et al. 1989). Large pieces of debris in streams influence the physical form of the channel, the movement of sediments, the retention of organic matter, and the composition of the biological community. Debris can facilitate the forming and stabilizing of gravel bars by accumulating sediments, and can be instrumental in forming pool habitat by directing or concentrating flow in the stream to scour pools or by impounding water. Trout use wood associated cover, especially during periods of high flows, when the lower velocity areas created by the debris may offer one of the few suitable refuges within the main river channel. Field studies conducted by the Department (Kiefling 1990) in the project area indicates approximately 30 percent of the within channel snags associated with the Snake River were providing good fish cover. Woody debris can also be responsible for the retention of organic matter that is used by aquatic invertebrates that trout feed upon. The above referenced studies also found that habitat associated with snags provided 2 to 3.5 times as many aquatic invertebrates when compared to riffle areas.

With the continuation of flood control, there will be a corresponding increase in residential, commercial and recreational development of the floodplain behind the levees. This has, and will continue to have, a significant cumulative impact on fish habitat, especially in spring creek tributaries, from increased siltation, removal of bank cover, and acid water pollution as a result of floodplain development.

Terrestrial Resources

The long-term maintenance of the levee system would perpetuate the ongoing deterioration of riparian, wetland, spring creek and main channel habitat. More subtle ecological effects of the levee system are changes in vegetation behind the levees which will gradually result in loss of diverse habitats for riparian wildlife species like moose, passerine birds, great blue herons, eagles and other raptors. With the elimination of major channel movement outside the levees, wetlands are not being replenished and many of the oxbows and side channel wetlands are being lost due to siltation and probable interception of ground water by the toe of the levee. This will have an overall negative effect on area waterfowl and furbearers.

The indirect or secondary effects of levees are potentially as detrimental to the area wildlife as are direct effects. Though the levees provide flood damage protection to important vegetation for wildlife, they also encourage residential development in areas previously restricted because of flooding. Eventually residential development will increase behind the levee to a point where only the very tolerant and adaptable wildlife species will exist. The existing levee has had significant effects on area wildlife.

Vegetation

The restricted levee system has resulted in increased water volume and velocities confined within the main river channel, increased erosion of islands, and a net loss of riparian habitat within the confines of the levees. The levee project does protect some important floodplain vegetation used by wildlife from flood and erosion damage. However, certain vegetative communities need disturbance associated with periodic flooding to propagate and survive.

The stability and vigor of the narrowleaf cottonwood community is dependent on the dynamics of the flood regime (Snyder 1980). Two ecological parameters are critical for maintenance and long-term stability of cottonwood-willow ecosystems: 1) frequency, duration and seasonal timing of flooding, and 2) soil moisture conditions during the growing season (Snyder 1980). Land management practices and watershed manipulations (principally water diversion and consumption) can radically alter relative plant compositions. The construction of river impoundments and consequent reductions in winter-spring flood surges has been one of the primary causes of long-term riparian woodland degradation (Snyder 1980). Akashi (1988) conducted research on the cottonwood community of the Big Horn River above Yellowtail Reservoir and linked the recent decline of the cottonwood forest to reductions in younger age classes of cottonwood. The most probable cause of forest reduction was the lack of seasonal fluctuation in river flow caused by upstream diversion and storage, which in turn stabilized stream flows. Alteration or elimination of higher flows can lead to the long-term degradation or elimination of riparian plant community dominants. If the natural flooding process is slowed or eliminated, cottonwood and willow would be replaced by more drought tolerant species. Thus, periodic flooding is extremely important for regulating the productivity and continued natural regeneration of the narrowleaf cottonwood-willow community.

Construction and operation of the levees may also affect subsurface hydrology by impeding the movement of water beneath the levee in a westerly direction. The natural flow of subsurface water in the project area is in a westerly direction toward Wilson as result of the tilting from the Teton Fault. It appears that ground water backs up against the levee on the east side of the river and its flow is restricted by the west levee; thereby, causing a lowering of the water table. This effect may be caused by interception of the subsurface water flow by the toe of the levee, or by subsidence and compaction of the levees. Some long-term valley residents believe this subsurface restriction contributes to the dewatering of areas such as Lake Creek (Personal communication with residents). This restriction of ground water flow could cause a lowering of the water table resulting in the loss of narrowleaf cottonwood stands through desiccation.

Because cottonwood reproduction will not occur beneath a vegetative canopy (Snyder 1980), floodplain movement and alteration are necessary to maintain conditions conducive to cottonwood tree growth. The levee system obstructs water movement associated with periodic flood events, critical for cottonwood regeneration, causing the maintenance of a narrowleaf cottonwood community to be inhibited. Within the project area, the cottonwood-willow riparian ecosystem are being replaced by spruce/cottonwood forest dominated by spruce in more mesic areas, and sage grasslands in more xeric areas.

The extent of the flooding within the project area that is regularly flooded has been significantly reduced because of the levees. As a consequence, this has resulted in major reduction in the areal extent of flooding of shrub willow/cottonwood and forested cottonwood habitat. Habitat types that are influenced by flooding have been reduced by 43 percent (Table 12) from the preleveed level of 2,761 acres in 1956 to 1,176 acres by 1986. Much of this loss has occurred to habitats lying within the levees, especially to the shrub willow community (Appendix 6a), forested islands, and cottonwood stands (Appendix 6b), as a result of erosion from constant channel changes induced by the levees.

The riparian vegetation behind the levees has matured and older aged stands dominate these areas. Prior to the levees there were 1,781 acres classified as mature cottonwoods (Appendix 6c and d), whereas, in 1986 the acreage for this habitat type had increased by 57 percent to 3,128 acres. Mixed cottonwood/spruce and spruce stands (Appendix 6e) have also shown an increase from a prelevee level of 770 acres to currently 1147 acres. In areal extent, the amount of forested cottonwoods has not changed significantly, and are very close to the prelevee level (5,318 versus 5,418 acres today). What is alarming about these statistics, however, is that riparian cottonwood habitat is not being adequately replaced and as it matures will be gradually displaced by more arid habitat like spruce and sage grass lands. This is especially evident in areas above the Gros Ventre River and in the South Park Area. Aspen stands within the project area are also not being replaced and have shown a reduction from 835 to 663 acres during the 1956-1986 evaluation period.

Unconsolidated (gravel and cobble) stream bottom or channel areas has been reduced from a prelevee level of 2,511 acres to approximately 2,000 acres presently (Appendix 6f). Whereas, unconsolidated shores have shown a net increase from 1,120 acres to 1,514 acres during the evaluation period (Appendix 6e). These figures do not, however, convey the complete story. The formerly braided channel ecosystem has largely been transformed by the levee system into a single channel environment. As a result, the extent of

TABLE 12: Habitat Changes Within the Project Area Since the Initiation of Federal Levee Construction in 1956.

Habitat Type	Prelevee (Acres 1956)	Present (Acres 1986)	Change In Acres
Flooded			
Aquatic Bed	36	350	+ 314
Unconsolidated Bed	2,511	2,007	- 504
Regularly Flooded			
Unconsolidated Shore	1,120	1,514	+ 394
Emergent Wetlands	1,627	2,354	+ 727
Forested Cottonwoods	1,019	259	- 760
Shrub Willows & Cottonwoods	1,742	916	- 826
Infrequent to Rarely Flooded			
Forested Cottonwoods (medium age)	1,983	1,183	- 800
Forested Cottonwoods (Mature)	1,781	3,129	+ 1,348
Forested Cottonwood/Spruce	533	829	+ 296
Spruce	177	318	+ 141
Aspen	835	663	- 172
Grasslands	4,382	4,215	- 168
Uplands	958	966	+ 8

main channel habitat has increased at the expense of side channels. Thus, the loss of side channel habitat is far greater then 504 acres indicated. This has resulted largely to the levees inducing constant channel changes and perpetuation of unstable conditions in less restrictive levee reaches where the river dissipates its energy and drops its bedload. Thereby, unconsolidated gravel and cobble bars and islands are concentrated in large expanses within or adjacent to the main channel, where formerly they were well distributed throughout the braided floodplain in the form of bars and islands (Appendix 6e).

Over the short term the levees have increased the extent of aquatic bed or plant habitat within the project area. Since the construction of the levees this habitat type has increased from 36 to 350 acres. Some of this increase can be attributed to the levees, however, much of the increase has resulted from landowners damming spring creeks and excavating areas. Emergent wetland (Appendix 6f), primarily wet meadows, have also increased from 1,627 acres in 1956 to 2,354 acres at the present time. Expanded irrigation (405 acres), especially in the South Park Area, has been the primary factor resulting in the increases to this habitat type.

Grassland and upland habitats have not shown a significant change since levees were constructed. On the other hand, these habitat types have been significantly altered by floodplain residential development, particularly in the Wilson area and at the confluence of the Gros Ventre River.

Birds

Riparian cottonwood stands are important for maintaining a wide diversity of bird species. Stratified foliage profiles found in the narrowleaf cottonwood community create numerous micro-habitats conducive to high passerine density and diversity. The diversity and interspersion of plant forms associated with riparian woodlands satisfies the habitat requirements of many area wildlife species which cannot be supplied by other nearby ecosystems (Snyder 1980). The cottonwood community along the Snake River provides breeding, roosting and feeding sites, and frequently, riparian cottonwood areas supply the only suitable stopover habitats for many migrating birds.

The cottonwood-willow community appears to be the major factor controlling avian population within the project area. The negative impacts on riparian avifaunna associated with the levee project include the continued decline of the cottonwood community, deterioration of habitat complexity, and subsequent development behind the existing levees. Finch (1989, in press) noted that the loss of habitat layers prevented habitat occupancy of certain foraging guilds, consequently resulting in declines in total bird abundance and species richness. Guilds that depended on tree trunks or tree canopies for their food supply necessarily vanished from riparian avifaunas when cottonwoods disappeared (Finch 1989, in press). Impacts from the levee system will result in the propagation of a more xeric resistent vegetative community behind the levees, which will support a less diverse and abundant avifauna.

Ducks, geese, swans, herons and cranes are dependent on riparian and wetland habitat of spring creek tributaries, beaver ponds, oxbows, and stable islands. Resident or migrating waterfowl use these habitat types for breeding, nesting, brood rearing, resting and wintering. The continued reduction or elimination of flood flows in the floodplain behind the dikes will significantly reduce the creation of wetlands. As wetlands age and phase out waterfowl production will be adversely affected. The constrictive nature of the levees will continue to erode important riverine islands suitable for waterfowl nesting.

The levee system has, in the short term, been beneficial to trumpeter swans. The silt deposition that presently accumulate in spring creek tributaries and the old side channels has established and maintained vascular aquatic vegetation that swans feed upon. Some of these gains will be negated since wetland habitats are not being replenished and many of the oxbows and side channels are being lost due to siltation.

The direct and indirect cumulative impacts from the levee system will result in the loss of suitable raptor perching, nesting, roosting sites and security cover ultimately reducing habitat suitability for resident as well as migrant raptors. In addition, the loss of the narrowleaf cottonwood community would result in prey base reduction, thereby substantially reducing the area's forage value to raptors. The aforementioned impacts on local avifauna will reduce the availability of avian prey, used extensively by falcons. Owls and hawks would find a reduction in the terrestrial prey base, a function of the sparse vegetative understory associated with more xeric environments. Historical nesting, perching and roosting sites would eventually deteriorate and be lost. Ospreys and eagles would be forced to select alternative or secondary habitats of lower quality which in turn may reduce future nesting success.

All avifauna will be impacted to some degree by the levee system. Tolerant species are the most generalized in their habitat choice and will be least influenced by habitat alteration. Intolerant species having the most restricted habitat use patterns and regarded as habitat specialists will be adversely affected by loss of their preferred habitat. Consequently, the area will become unsuitable for some breeding populations. For individual species, habitat requirements and usage patterns may change with the seasons, as well as the degree of specificity in habitat selection.

Small Mammals

The vegetative understory beneath cottonwood stands provide a diversity of micro-habitats within the project area. This diversity translates directly into numerous available resource dimensions for mammals to exploit. The availability and diversity of resource dimensions leads to a greater diversity and abundance of mammalian species. The eventual habitat alteration, or change of structurally complex habitats to less diverse habitat types, associated with the levee system would be a negative impact to mammals within the project area. Habitat values to wildlife would be reduced and realized by lower mammal diversity and densities.

Mesic riparian environments are preferred by a variety of small mammals due to the multi-layered cover, which provides security, and to the abundance of food located within the shrub understory (Snyder 1980). The effects of habitat alteration or reduction to shrews, voles, mice, woodrats and ground squirrels would be the loss of available security cover such as leaf litter and windfallen trees, and of the various plant material, seeds and fruits used as a food source.

Porcupines, weasels, coyotes, red foxes, bobcats and bats all rely heavily on riparian cottonwood stands to provide sufficient food, cover and other essential habitat requirements. Muskrat, beaver, mink, and river otter are dependent on the ecotone between the terrestrial and aquatic resource. The levee system reduces this ecotone, thus reducing habitat for these species. Deciduous tree species would be substantially reduced or eliminated and replaced by spruce, thereby further reducing available habitat for beaver, which is heavily dependent on willows and cottonwoods for food, and lodge and dam construction. In addition, muskrat, mink, and beaver provide trappers and sportsmen with furbearer trapping opportunities and supplemental income; eventually both will be reduced by the effects attributable to the levee system.

Large Mammals

Human activities have caused a significant loss of elk wintering habitat in the Snake River floodplain. A portion of the Department's South Park Habitat Unit that winters elk may be adversely affected if the levees are not maintained in this area. It is possible that the river, accelerated by effects of upstream levees, may erode the southern portion of the unit. As a result, as much as 150 acres of wintering habitat may be lost to the river. Any further degradation of the riparian vegetation, especially in the Blue Crane/Spring Creek area, would also adversely affect wintering elk.

Crucial winter range for the Fall Creek and Jackson moose herds lies within the project area. The extensive channel alterations that have occurred over the years have restricted establishment of preferred shrub vegetation for moose (Houston 1968). The shrub willow and cottonwood vegetation has been reduced by 48 percent from its prelevee level of 1,742 in 1956 to 916 acres in 1986 (Table 12). The levee system has precluded the natural meandering of the river which has ultimately resulted in the loss of in-channel islands, willow production, and small ponds that normally enhance moose forage production. In addition, reduction of forage and cover has resulted from subsequent residential and recreational development within the floodplain areas essential to wintering moose.

Since crucial winter ranges for pronghorn and mule deer are not located within the project area, these species will not be greatly affected by the project. Mule deer use the project area primarily from late spring to fall and then migrate to their major winter ranges. The small number of pronghorn that summer within the project area migrate to winter in the Green River Basin. Bison winter out of the project area within the National Elk Refuge and summer in the Grand Teton National Park. Migratory movements of ungulates between seasonal ranges have not been affected by the levee system;

however, they could be with the increased rate of residential and recreational development that is presently occurring.

Amphibians and Reptiles

Herptiles are impacted to varying degrees by the levee system. Amphibians are restricted to moist habitats, since their scaleless skin is permeable and subject to water loss when exposed to dry air. In arid regions, amphibians remain buried in moist soils during daylight hours and emerge to feed at night (Baxter and Stone 1980). Therefore, amphibians would be negatively impacted by the conversion of a mesic environment to a more xeric condition. Reptiles would be more positively impacted by the xeric conditions. Reptiles have become adapted to living and reproducing entirely on land. Their skin is dry and normally covered with scales or bony plates to reduce water loss from the skin and as protection (Baxter and Stone 1980). Regardless, the levee system will eventually cause reduction in habitat diversity which will result in a reduction of herptile species composition within the project area.

Endangered Species

Bald Eagle

Over 58 percent of the bald eagle nesting habitat in the Greater Yellowstone Ecosystem (GYE) is closely associated with private lands and susceptible to development. At least 6 nest sites have been lost to development and conflicting land use in the GYE since the mid 1960's and available habitat is steadily declining.

Currently, there are 21 areas where bald eagles nest in the Wyoming portion of the Snake Unit. At least 12 (57 percent) of these pairs nest in areas closely associated with private lands subjected to development. At least 6 (29 percent) of these pairs are associated with portions of the river that are directly impacted by the levee system. Only 9 (43 percent) of the Snake Unit nest sites are not likely to be impacted by habitat degradation associated with the levee system or development on private land. These nine nesting locations are completely surrounded by lands administered by the U.S. Forest Service (2 sites), Grand Teton National Park (6 sites), and Yellowstone National Park (1 site). However, this encompasses 43 percent of the occupied habitat and has produced 23 (19 percent) of the 122 young fledged in the Snake Unit since 1982.

Detailed analysis of bald eagle movements and nest site selection document that bald eagles avoid human disturbance (Harmata 1989). Human activity and development within 400 meters of the river reduce the amount of habitat available to eagles (Montopoli 1987). Levees allow for housing developments in the floodplain and within bald eagle habitat. Since 1978, at least 3 instances are documented where bald eagles have relocated in an apparent response to the construction of houses (Oakleaf 1989). In addition, one nesting location was permanently abandoned due to the development of the Solitude Subdivision in 1981.

Harmata (1989) evaluated the importance of river diversity pertaining to nest site selection by eagles and found it to be highly correlated, as was low human disturbance. Based on these findings, he developed an index to quantify river diversity (RDI) using a modified Shannon's index of diversity. He found that stretches of rivers that were frequently used during daily activity patterns had significantly ($P<0.05$) higher RDI's than river sections that had low use values. Applying the RDI to the levee system indicates that as a river reach becomes more restricted by levees, a lower RDI value and corresponding low eagle use would be expected.

Peregrine Falcon

The eventual effects of the levee system on riparian and wetland habitats could have adverse impacts on peregrine falcon foraging habitat. Wetland habitats with an abundant avian prey source are important hunting areas for peregrines. Degradation of floodplain vegetation will result in habitat losses and lower avifauna densities. Potential loss of aquatic and wetland habitats is of particular concern since these are important peregrine foraging areas.

Whooping Crane

Whooping cranes have been documented utilizing riverbottoms within the area in the spring, selecting wetland sites for feeding, resting and roosting. The major habitat types used by whooping cranes include seasonally flooded and permanently or semi-permanently flooded wetlands along spring creek tributaries and upland types associated with irrigated hayfields. Human encroachment in these preferred sites would restrict bird use, forcing whoopers to select secondary or alternate habitat sites, which could potentially affect future nesting territory establishment along this reach of the Snake River.

Grizzly Bear

Given the wide range of prey items consumed by grizzlies and the low probability that they use the area, the levee system will likely have minimal effect on their overall food supply. The study area is outside the grizzly bear recovery area; however, it is conceivable that grizzlies could wander onto or through the area given their large home range size and the tendency for subadults to disperse.

Recreation

The levee project area is a popular site for recreational pursuits throughout the year. The indirect and cumulative effects of changes in natural vegetation, subsequent development and increase in human numbers could have far reaching consequences for various recreational activities. At a minimum, the quality of outdoor activities will increasingly diminish as more resource cushion becomes lost by spin-off development and the aesthetic appeal of the area decreases.

As the floodplain develops, there will be more pressure on Department to further restrict, or even eliminate, big game hunting. Due to landowner concerns, the area north of the Wilson Bridge has been restricted to archery hunting only for deer and closed for the hunting of moose and elk. Any further decline in aquatic habitat and the associated cutthroat fishery could have significant effects on the use of this resource. Professional guides and fishing-related businesses have already expressed concern that the Jackson Hole area has been losing fishing clientele to quality fisheries that have been developed in adjacent states (Phillips 1987).

EVALUATION OF PROJECT ALTERNATIVES

Future Without Condition and Alternative A

For our analysis of these alternatives we assumed a continuation of the existing conditions, which would involve ongoing maintenance efforts for all the levees in the Jackson Hole area by Teton County and emergency assistance from the Corps. The future without project condition and Alternative A (no action) would basically involve the same degree of maintenance and have similar effects on fish and wildlife resources.

This alternative would not provide the level of levee upkeep as the Federal maintenance alternative. As a consequence, the extent of repairs needed during emergency operations would be greater. Emergency repairs could have locally significant impacts on fish and wildlife habitat, especially if they were conducted in or near spring creeks or bald eagle nests.

As indicated in the previous section, the existing levee has had significant effects on area fish and wildlife. The long-term maintenance of the levee system would perpetuate the ongoing deterioration of riparian, wetland, spring creek and main channel habitats. The riparian zone behind the levees would become more xeric; as cottonwood stands mature they will be replaced by spruce, or in drier areas, by sage grasslands. The ecological effects nearer to the levee will be more subtle, but the progression toward a less diverse and productive riparian ecosystem appears inevitable. The cumulative effect of this progression to a more xeric vegetative community will have significant effects on area wildlife, especially those dependent on riparian zones like moose, passerine birds, great blue herons, bald eagles and other raptors.

The erosion of forested islands and cottonwood stands within the levees will continue, possibly at a more accelerated rate as fewer forested areas remain. These vegetative types are not being replaced because erosion from constant channel changes is precluded by the levees. The result of this habitat loss will be a major reduction in the diversity of the Snake River floodplain ecosystem. This loss would be significant to in-channel habitat for cutthroat trout, riverine habitat diversity for bald eagles, and essential habitat for furbearers like otter, mink, and beaver. Additional impacts would occur to populations of cutthroat trout with the removal of fallen trees and other woody debris during annual O&M.

With the elimination of major channel movement by the levee system and in non-leveed areas by construction of channel blocks, wetlands will not be replenished and many of the oxbow and side channel wetlands will eventually be lost to siltation. These wetland losses will have an overall negative effect on area waterfowl and furbearers. The blocking of historic river channels has and will continue to have a significant effect on riparian regeneration and the formation of wetlands and side channel habitat.

Areas below the levee sections and river reaches within the project area that are not significantly controlled by levees; e.g., the South Park area and in the vicinity of the Gros Ventre River, will continue to be impacted as the river dissipates its energy and drops its bedload within these reaches. The perpetuation of unstable conditions that exist in these less restrictive levee reaches will significantly affect some of the most important fish and wildlife habitat within the Jackson Hole Valley. These areas are extremely important habitats for nesting bald eagle and geese, spawning cutthroat trout, and wintering big game. Any further degradation of these habitats would be very detrimental to fish and wildlife.

The lost capacity for flood flows to flush sediments from spawning grounds in spring creeks would continue to cause a steady decline in the suitability of spawning areas for cutthroat trout as well as the reduced capability of fish to reach these areas. Critical spawning habitat for these fishes would eventually be lost or have to be artificially maintained in order to sustain a natural spawning population of Snake River cutthroat trout. Presently the maintenance of these important spawning and nursery areas is being borne by sportsmen funded rehabilitation projects conducted by Wyoming Game and Fish Department, local groups, or private landowners.

With the continuation of flood control there will be a corresponding increase in residential, commercial, and recreational development of the floodplain behind the levees. This has, and will continue to have, a significant cumulative impact to fish and wildlife, especially in the areas near spring creek tributaries.

Alternative B

This maintenance alternative would involve the Corps assuming over the responsibility for annual maintenance of all Federal and non-Federal levees. This alternative would be very similar to Alternative A, except for the entity responsible for maintenance, and possibly a more proactive form of maintenance with Federal funding for the affected levees. The need for emergency repairs during flooding would be significantly reduced under this alternative. With a more proactive maintenance program, better planning for the immediate protection of fish and wildlife resources (bald eagle nests and cutthroat spawning habitat) could possibly occur. However, with a higher degree of levee maintenance provided by this alternative, there would be a corresponding improvement in flood protection and containment of higher flows. If this were the case, the ongoing long-term impacts associated with reduction of higher flows on fish and wildlife would be greater and possibly accelerated.

The impacts on fish and wildlife of this alternative will depend largely on the standards to which non-Federal levees will be maintained, the extent to which currently "substandard" levees will have to be rebuilt, and the number and location of "channel plugs" required during flood fights to prevent avulsion damage (channel shifting) in non-leveed reaches. The Project's Draft Environmental Statement (Corps 1989b) indicates that channel blocks, which would be built by the local sponsor during flood fights, would be "evaluated on an engineering, economic and environmental basis for removal, or retention, after a flood fight". The Federal levee extension and many of the non-Federal levees in the South Park area were initially started as channel blocks and expanded by the Corps with emergency funding. The continuation of this process could eventually lead to the piece-meal leveeing of the entire Jackson Hole Valley without recognition of and mitigation for the cumulative environmental impact. The cumulative affect of this adhoc levee building has and will continue to have significant affect on riparian regeneration and the maintenance and formation of wetland and side channel habitat.

With the elimination of major channel movement outside the levees, wetlands are not being replenished and many of the oxbows and side channel wetlands are being lost due to siltation and probable interception of ground water by the toe of the levee. As a result, habitats associated with the historic braided channel ecosystem will continue to degrade from their former productive status as forage areas for big game, nesting habitat for raptors and songbirds, spawning and rearing areas for trout, and wetlands which support many varieties of waterfowl. More subtle ecological effects resulting from the operation and maintenance of the levees will be changes in vegetation behind the levees which will gradually result in loss of diverse habitats for riparian wildlife species like moose, passerine birds, great blue herons, eagles and other raptors.

The lost or reduced capacity for flood flows to flush sediments from spawning ground in spring creeks will continue to contribute to a steady decline in the quality of spawning areas and reduced capacity of fish to reach spawning and rearing habitats. In addition, certain other important components of trout habitat as fallen trees and other woody debris in the river channel will be subject to removal during annual O&M.

Improved flood protection and a greater assurance of Federal involvement during flood fights will result in increased residential, recreational and commercial development within the flood plain. The mere presence of levees and the maintenance thereof gives many people "false" security that they will be protected from flooding and encourage them to proceed with unwise development. Floodplain development has, and will continue to have, a significant cumulative impact to fish and wildlife, especially in the areas near spring creek tributaries. The confluence of spring creeks are important nesting and feeding areas for bald eagles. Since 1987, at least three instances have been documented where bald eagles have relocated their nests in the apparent response to the construction of houses within the project area. In addition, one nest location was permanently abandoned due to the development of the Solitude Subdivision within the north portion of the project area in 1981. Under both Alternative A & B, two or three bald eagle territories could be significantly impacted or even abandoned. Eventually development will increase behind the levee to a point where only the very tolerant and adaptable wildlife species will exist.

Portions of the levee do protect important fish and wildlife habitat from impacts associated with the levee system, especially the flood plain areas near Blue Crane, Spring, and Bar BC Creeks and the Department South Park Habitat Unit. If levees in the area were not maintained, these areas would be significantly impacted by the lateral instability of the river channel resulting from the release of energy and sediment from upstream levee reaches. We are not advocating that the existing levees are the best remedy for protecting the spring creeks, but until a better solution is found, we recommend that crucial levee segments be maintained. Their loss could result in a very significant impact to this extremely valuable assemblage of fish and wildlife habitat. Spring creeks, besides their value for cutthroat trout, also provide very important habitat for nesting and wintering habitat for waterfowl, winter habitat for trumpeter swans and big game, and nesting habitat for three of the six nesting bald eagle pairs within the study area.

This alternative will require the development of a new quarry for riprap material. The Corps recently completed an investigation where 20 potential quarry sites were evaluated to determine which site had the most desirable geological and logistical characteristics. This report, entitled "Jackson Hole Wyoming Geological Reconnaissance and Quarry Investigation", dated April 1989, describes the location, geological characteristics, and physical characteristics of the 20 potential sites studies. A map showing the 20 sites and a part of the report's Table 2 showing the corresponding name and location of each numbered site on the map are included in this report as Appendix 7. A number of the above-mentioned sites are no longer under consideration for a variety of reasons. It is our understanding that potential quarry sites still under consideration include the Curtis Canyon, Flat Creek Talus, Teton Pass, and Phillips Ridge, and the existing Hansen site, and Walton sites. Table 13 summarizes resource concerns pertaining to specific quarry sites and the Service's preference for development

The Hansen site is an existing quarry that has been used occasionally as a source of riprap material for the levees. This site is immediately south of the junction of the Gros Ventre River and the Snake River in T41N, R116W, Section 5. The area is considered crucial winter ranger for deer, crucial winter/yearlong habitat for moose, and spring, summer, and fall range for elk. The site is within a bald eagle nesting territory and near one eagle nest. Quarry mining at this site has been a concern in the past and could have significant effects on this nesting pair of eagles if the quarry is operated during the nesting season. Our overall analysis indicates that quarry development at the Hansen site would cause the most environmental damage of the 6 sites, thus we have ranked this site as the least favorable.

The Flat Creek Talus site, referenced as site #4 in the Corps' quarry site study, is located 2 miles east of the intersection of Flat Creek and the National Elk Refuge/Bridger-Teton National Forest boundary and is characterized by very steep slopes and vertical cliffs with talus deposits

Table 13. Summary of wildlife resource concerns pertaining to quarry sites and Services preference for the development.

Preference	Quarry site	Special Concerns
1	Teton Pass	Spring - fall range for big game . Development will have little impact on wildlife.
2	Phillips Ridge	Spring - fall range for big game. Site near a peregrine falcon release area. However, associated impacts can be mitigated.
3	Walton	Spring - fall habitat for deer and elk, and crucial winter/ yearlong range for moose; foraging area for bald eagles and peregrine falcons. Impacts to wildlife species can be mitigated.
4	Curtis Canyon	Crucial winter range for elk, mule deer, bighorn sheep, and moose. Habitat impacts would be difficult to mitigate and quarry activities restricted from December - April to protect wintering big game.
5	Flat Creek Talus	Crucial winter range for elk, mule deer, bighorn sheep and moose; nesting habitat for raptors. Due to its high utilization by bighorns and importance to other wildlife, habitat impacts would be extremely difficult to mitigate. This site would also require the above reference seasonal restriction.
6	Hansen	Crucial winter range for mule deer and moose and spring - fall range for elk. The site is near bald eagle nests and foraging areas. Activities at this site would adversely impact this eagle nesting territory and impacts would be extremely difficult to mitigate.

at the base. This site is considered crucial winter range for bighorn sheep, elk, deer, and moose, and is the lower elevation site most consistently used by bighorns in the Jackson Hole area. The area has a restriction on human activities from December 1 through May 1, in order to protect these big game species. The project site is occupied by prairie falcons and is near a potential peregrine falcon nest site. In addition, the site is approximately 2 miles from a peregrine falcon hack site. Our analysis indicates that development of the quarry at this site would be the next most environmentally damaging of the 6 sites and we have ranked this site #5.

The Curtis Canyon site, which is listed as site #1 in the Corps' quarry investigation, is located on U.S. Forest Service property just southeast of the National Elk Refuge. This is the only site identified in the Corps' investigation that has desireable geologic and logistical characteristics. The quarry site would be located on a steep south and southeast-facing slope that forms the northwest wall of Curtis Canyon. The vegetation at the project site consists mainly of grasses and sagebrush with some small stands of spruce and aspen. The area is crucial winter ranger for elk, mule deer, bighorn sheep, and moose and has a restriction on human activity from December 1 through May 1. Our analysis of this site indicates that development would cause significant impacts to wildlife habitat and we have ranked this site #4.

The Walton quarry is located adjacent to the Snake River on the west side of Gros Ventre Butte in T42N, R116W, Section 7 and is about one mile southwest of the Hansen quarry. The project area is considered to be crucial winter/yearlong habitat for moose and spring, summer, and fall habitat for deer and elk. Bald eagles and peregrine falcons are present in the project area; however, the quarry would probably not have major effects on nesting by these birds. Based on the significance of potential wildlife impacts at this site, we have ranked this site #3.

Phillips Ridge is listed as site #7 of the Corps' quarry investigation. This site is about 4 miles west of Wilson toward Teton Pass and is located on a heavily timbered ridge north of State Route 22, and is on U.S. Forest Service property. Development at this site would not cause significant impacts to wildlife species since the area is primarily spring through fall habitat for big game species. The project area is within one mile of a peregrine falcon hack site located in Phillips Canyon. If this site were developed, quarry activities may need to be restricted during the month of July. Based on our analysis we have ranked this site #2.

The Teton Pass site, which is described as site #8 in the Corps' quarry investigation, is located about 2 miles west of Trail Creek Ranch in T41N, R117W, Section 19 on U.S. Forest Service property. The site is situated on a mountainside, which was previously blasted to make a cut for the old Teton Pass Road. This area provides primarily spring through fall habitat for big game species. The development of this site would cause the least significant impacts to wildlife species of the six sites we analyzed. We rank the Teton Pass site as #1 in preference for development.

Based on our preliminary analysis, the Teton Pass site is the preferred alternative based on our environmental analysis. This site would probably require very little, if any, mitigation measures to offset habitat losses. We believe the Corps should strongly consider the Teton Pass site and possibly the Phillips or Walton Ridge sites for future quarry development given the extensive mitigation that would be required to offset losses to crucial big game winter range at the other sites. Any development at the Flat Creek Talus site or the Curtis Canyon site would also require road access across the National Elk Refuge, a right-of-way permit from the refuge staff, and very stringent seasonal restrictions to assure winter operations on the refuge would not be disrupted (Refer to Service's letter included in Appendix 8).

MITIGATION AND ENHANCEMENT RECOMMENDATIONS

The Service has reviewed the proposed levee project in accordance with provisions of the Fish and Wildlife Coordination Act (46 Stat. 401, as amended, 15 U.S.C. 661 et seq.) and its Mitigation Policy (CFR, Vol. 4, No. 15, pp. 7656-7663, 1981). The Mitigation Policy provides guidance on mitigation for project-related impacts.

The aquatic and wetland/riparian habitats that will be affected by the project are of high value and becoming scarce on a national basis. The mitigation goal is no net loss of in-kind habitat value. The Service will recommend ways to avoid or minimize losses. If losses are to occur, we will recommend ways to rectify, reduce, or eliminate them over time. If losses remain likely to occur, the Service will recommend that those losses be compensated by replacement of the same kind of habitat value so that the total loss of such in-kind habitat value will be eliminated.

The existing levee project has resulted in considerable habitat losses to fish and wildlife resources. In view of this, we believe it is essential that the maintenance project incorporate a program to maintain and restore to the greatest extent possible, the long-term productivity of this ecosystem. The Water Resources Development Act of 1986 (Water Bill) provided several important provisions that could help to accomplish this end; these being Sections 906(b) and 1135. Section 906(b) provides authorization for mitigation features (including land acquisition from willing sellers) to mitigate damages to fish and wildlife resulting from any water resource project under the Secretary of the Army's jurisdiction, whether completed, under construction, or to be constructed. Retrofit mitigation features for previously authorized and constructed projects costing up to 7.5 million dollars or 10 percent of the total project cost may be implemented without further specific reports to Congress. Section 1135, which has recently been extended for another three years by Congress, authorizes the review of projects constructed before enactment of the Water Bill to assess the need to modify structures and operations of water resource projects for the purpose of improving the quality of the environment.

We strongly advocate that the two referenced sections of the 1986 Water Bill be pursued by all entities to fund the development and implementation of a plan to restore and maintain this ecosystem of national importance. The plan must recognize that the restoration of this ecosystem should be viewed as a long-term mitigation plan and that the degree of success will depend on the extent to which natural channel and floodplain morphological features (e.g., islands, oxbows, side channels, wetlands, and forest ecotypes) are re-established and maintained. This approach needs to emphasize good cooperative relationships with floodplain landowners. Education programs should also be developed to assist landowners to recognize the value of preserving these bottomlands and possibly reimbursing these landowners through conservation and/or flood easements.

Therefore, we recommend that, under the Corps and Service leadership, a task force represented by landowners, natural resource groups, and local, State, and Federal agencies be established to develop a cooperative management plan to be implemented for the Jackson Valley of the Snake River. To facilitate the development of the plan, a variety of environmental and hydrological studies and surveys needs to be conducted. Information or study needs include:

1. Hydrological studies to evaluate existing and long-term effects of the levees on river, spring creek tributaries, wetlands and riparian areas. The U.S. Geological Survey, at our request, has developed a plan of study (refer to Appendix 9) that we recommend be used as a guide in the development of the hydrological study.

2. Wildlife baseline survey to determine the extent of utilization of the project area by species potentially most affected by the levees.

3. A fishery population study to collect baseline information by river segment to development site specific mitigation measures for both game and non-game species.

4. To facilitate the development of the above reference fishery mitigation measures, an aquatic invertebrate study should be conducted to assess the structural and functional changes of macroinvertebrate communities within leveed and non-leveed reaches of the project area.

5. A study to determine the status (species, distribution, density, interspersion, and regeneration capability) of the wetland and riparian vegetative community within the project area. For comparison, a similar area that has not been affected by levees should be surveyed and mapped.

6. In-depth analysis of present and potential impacts resulting from increased recreational and residential development of the project area, particularly for nesting waterfowl, wintering trumpeter swans, big game, bald eagles, and cutthroat trout.

7. Determine the probabilities of the viability of the existing system to provide flood control into the future. This assessment should

also address long-term levee maintenance and construction needs and the consequences they will have on fish, wildlife, and human resources.

8. A thorough evaluation of more environmentally suitable alternatives to protect fish and wildlife resources and property values in lieu of large levees, especially in areas not restricted by major levees. These alternatives should include, but not be limited to, setback levees, river training, and armoring in erosive areas with riprap, and flood and conservation easements.

9. Using the above data and findings, develop an information base to assist the task force in their development of a long-term plan for the Snake River floodplain within the project area.

Until a comprehensive management plan is developed and funded, it is recommended that conservation measures be implemented to minimize impacts of fish and wildlife resources by the project. These measures need to be specifically identified and incorporated into the O&M plan and decision documents for the levee project.

To maintain within-levee fish and wildlife habitat values, a program should be established to stabilize and protect important floodplain forested lands and stream banks from further erosion. This program should be implemented in association with river training measures to create and maintain substrate necessary for the perpetuation of riparian vegetation within the levees. In-channel fishery habitat losses should be compensated for by random placement of large angular boulders along the toe of dikes and islands. The levee debris clearing program should be designed to maintain as much woody material as possible to provide inchannel diversity for aquatic resources, as well as den sites for mink and otter and nest security for geese. Important fish and wildlife habitat removed during snag and drag operations should be mitigated in kind.

Remedial action also needs to be implemented to prevent further degradation by the levee system of fish and wildlife habitat associated with spring creeks and the less restrictive levee areas like the mouth of the Gros Ventre and the Spring Creek/South Park area. The interim maintenance of some of the levees in these areas may be necessary to protect important fish and wildlife resource values. In the long-term, it is recommended that a system wide solution be implemented to protect these important resources by less restrictive measures than continuous levees. Other environmental solutions that should be considered include river training devices, small sections of levees or groins, and armoring erosive areas with riprap.

The riparian cottonwood community and wetland habitats behind the levees will continue to decline and may be eventually eliminated without the periodic flooding needed for their maintenance. Measures should be implemented, where feasible, to allow periodic high flows into historic flood plain areas to maintain wetlands and riparian habitats. To facilitate water circulation within these habitats, existing diversion structures should be maintained and augmented in strategic habitat areas. A riparian maintenance plan should be developed by an interdisciplinary team to preserve the diversity and value of this ecosystem of national importance. This plan should be funded as part of the project's annual maintenance or through other processes that would provide the mechanism for long-term riparian habitat maintenance. In lieu of the above, if deemed more feasible, it is recommended that a flood and/or conservation easement be acquired from the lower portion of the Federal levee to the South Park Highway Bridge, and this area be managed for its fish and wildlife values. Measures would need to be implemented to reestablish this river to a state of equilibrium and to protect it from residential and commercial development and further degradation from upstream levees. These measures should be developed by an interdisciplinary team and funded and maintained for the life of the project.

The elimination of flood flows has also significantly reduced the ability of spring creeks to flush and replenish cutthroat spawning gravel. This has necessitated Department to established a program to replenish spawning habitat and improve spawning access to spring creeks in order to restore and maintain cutthroat populations in the Jackson Hole Valley. Since these are ongoing project related impacts, the costs associated with this fishery restoration and maintenance program should be borne by the project.

The levee maintenance program needs to provide for the protection and preservation of endangered species. Impacts associated with the project's levees and their continued maintenance are of great concern for the preservation of the bald eagle population residing within the project area. Implementation of the above conservation measures will greatly help to maintain habitat for this species; however, special measures will need to be taken during routine and emergency operations to further protect bald eagles. It is recommended that the Corps develop, in coordination with the Service and Department, nest site management and protection plans for individual bald eagle nesting pairs. To facilitate the protection of these nesting eagles funds should be made available annually to Department/Service to monitor (two aerial flights) nesting bald eagles and to coordinate annual plans for their protection from project activities.

All maintenance activities should be performed in a manner that meets State and Federal water quality standards. In this vein, a contingency plan should be developed and implemented to prevent the entrance or accidental spillage of contaminants, other pollutants, and waste into streams and ground water. Pollutants and waste of particular concern include, but are not restricted to, petroleum products and uncured concrete.

Therefore, until a long-term comprehensive plan can be developed for the project area, the Service recommends that the following interim mitigation measures be incorporated into the project's plans to assure that the existing fish and wildlife resource values are protected and maintained from existing on-going and anticipated future impacts associated with the O&M of the levee system:

1. To maintain riparian integrity and associated instream habitat, important forested islands and stream banks within the influence

of the Federal maintenance project should be stabilized and protected from further erosion (refer to Figure 26 for possible areas of consideration). We suggest that large angular riprap be used for this purpose.

2. To promote the succession and maintenance of riparian and forested island habitats, a program should be implemented to install river training devises or other measures to create conditions for island establishment and development.

3. To replace trout habitat lost as a consequence of levee and maintenance and continued habitat degradation, large angular boulders should be placed randomly along the toe of the dikes. The location and number of boulders should be coordinated with the Department.

4. To improve access to spawning areas by adult trout, offset dikes should be installed at the confluence of spring creek tributaries. These dikes should be designed by hydraulic engineers in consultation with the Department's fishery staff.

5. To help maintain riparian, wetland and aquatic habitats associated with cutoff side channels, existing diversion structures should be maintained and augmented at strategically located places to direct or allow for periodic high flows into the historic flood plain.

6. To compensate for the gradually increasing impacts to cutthroat spawning habitat in spring creeks due to the levee system (increased sedimentation from elimination of flushing), a permanent mitigation fund should be established to provide for their regular maintenance. These funds should be made available to the Department for this purpose.

7. To monitor and quantify the effectiveness of the spawning rehabilitation program, permanent fish traps should be constructed at project expense on major spring creeks used by spawning cutthroat trout.

8. To improve fish passage in Blue Crane Creek, the existing culvert in the haul road located below the Department's fish ladder should be replaced. A bottomless culvert or a bridge would provide significantly better fish passage.

9. A riparian/wetland maintenance plan should be developed by an interdisciplinary team, comprised of Corps, Department and Service representatives, to compensate for project-induced habitat losses that will accrue due to the elimination of flooding and associated downstream degradation by the project. The project should fund, on a continuing basis, the development and maintenance of the plan as well as the mitigative actions called for by the plan.

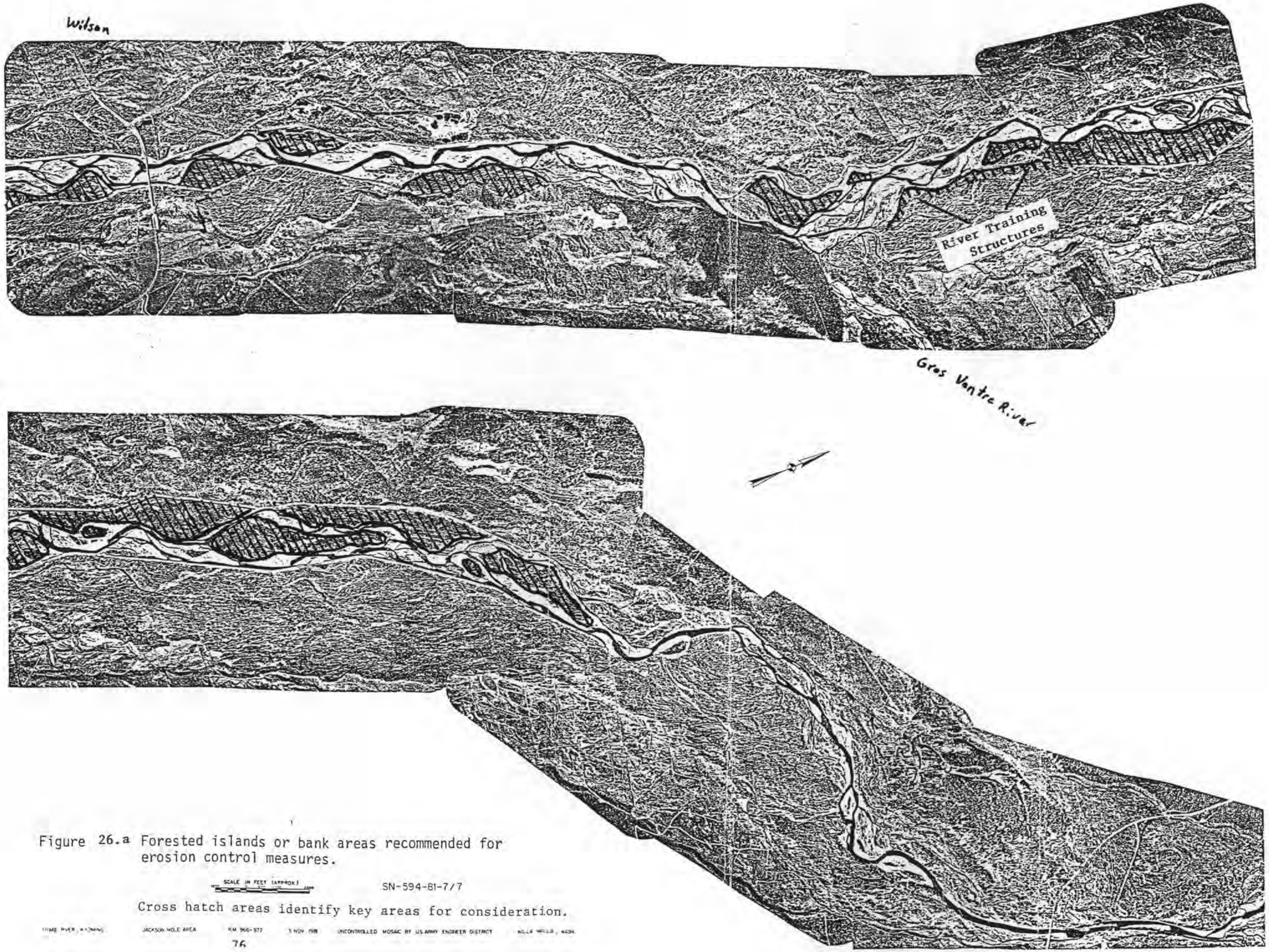


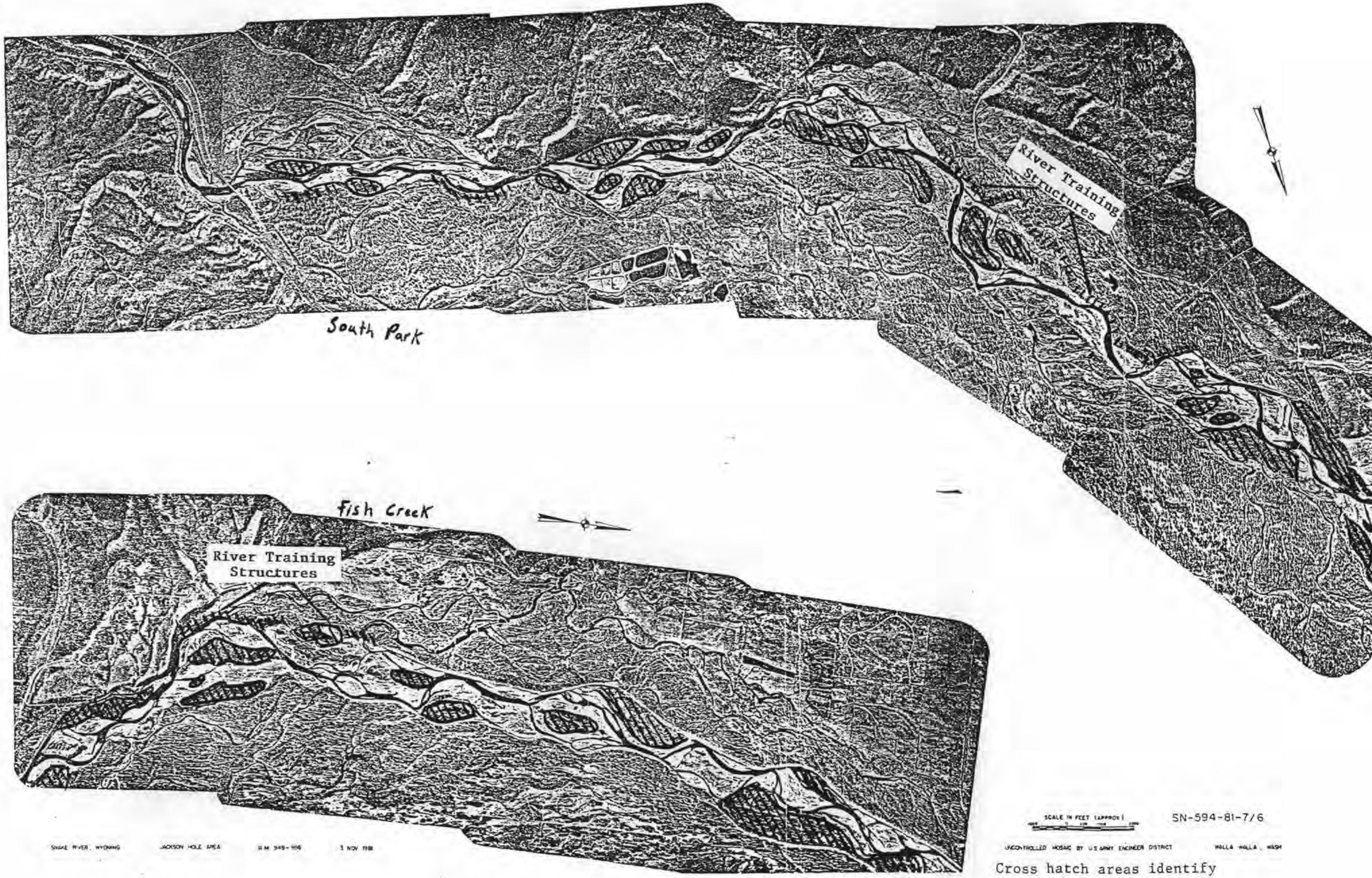
Figure 26.a Forested islands or bank areas recommended for erosion control measures.

SCALE IN FEET (APPROX)

SN-594-81-7/7

Cross hatch areas identify key areas for consideration.

SNAKE RIVER, WYOMING JACKSON HOLE AREA R.M. 966-972 3 NOV 1981 UNCONTROLLED MOSAIC BY U.S. ARMY ENGINEER DISTRICT WALLA WALLA, WASH.



Cross hatch areas identify
key areas for consideration.

Wilson Bridge

Figure 26.b Forested islands or bank areas recommended for erosion control measures.

In lieu this, if deemed more feasible, it is recommended that a flood and/or conservation easement be acquired from the lower end of the Federal levee to the South Park Highway Bridge, and this area be managed for its fish and wildlife values. Measures would need to be implemented to reestablish this river to a state of equilibrium and to protect it from residential/recreational development and further degradation from upstream levees. These measures should be developed by an interdisciplinary team consisting of Corps, Department, and Service personnel and funded and maintained at project expense.

10. To safeguard nesting bald eagles, levee repairs and maintenance should occur during the non-nesting season (August - February).

11. To protect the integrity of the nesting bald eagle territories within the influence of the project, site specific plans should be developed and implemented to ensure the long-term maintenance of these areas for this endangered species.

12. Funding should be made available annually to Department/Service to monitor (two aerial flights) nesting bald eagles and to coordinate annual plans for protection of this endangered species from project activities.

13. If any levee systems are phased out, a plan to safeguard important fish and wildlife resources should be developed by the Corps, with Department/Service assistance, and implemented.

14. To protect important resources associated with the Spring Creek/South Park area and the mouth of the Gros Ventre River from further degradation from the upstream levee system, the interdisciplinary agency team (See #9) should develop a plan for implementation to restore this river reach to a state of equilibrium. The plan should be implemented at project expense.

15. To protect fish and wildlife from future maintenance and construction actions, the following measures should be implemented:

    a. Clearing/snagging and maintenance

        1) Snag removal should be kept to an absolute minimum and only to the extent necessary to protect the levees.

        2) Fish and wildlife impacts associated with snag removal should be mitigated in-kind within or close to the channel reach in which they occurred.

        3) Work within stream channels should be kept to a minimum and conducted only during low flow periods.

        4) Disturbances in areas that contain woody vegetation, wetlands or spring creek tributaries should be avoided.

5) Work should be scheduled for late summer or fall to avoid disturbing birds and mammals during the breeding season.

6) All major activities should be coordinated with Department/Service staff to ensure protection of fish and wildlife.

7). A contingency plan should be developed and implemented to prevent the entrance or accidental spillage of contaminants, other pollutants, and waste into streams and ground water. Pollutants and waste of particular concern include, but are not restricted to, petroleum products and uncured concrete.

b. Levee access

1) Levees should be permanently accessed from existing roads or areas that avoid sensitive fish and wildlife areas.

2) Levee traffic should be routed to avoid sensitive fish and wildlife areas during critical periods, i.e., bald eagle nesting (February-July), and wintering big game (December-April).

c. Borrow material areas

1) Borrow areas should be located in open areas and avoid important fish and wildlife habitat, i.e., spawning, wintering, and nesting areas.

2) If material is taken from the river, it should be in areas of low fish and wildlife value that has been coordinated with and approved by the Department and the Service.

3) Upland borrow areas should be reclaimed to wetland habitats if feasible. The reclamation design of these wetlands should be coordinated with the Department/Service to maximize wildlife benefits. If the above is not possible, the area should be revegetated with native vegetation and any wildlife impacts mitigated.

d. Emergency maintenance

1) Activities should be confined to situations where human safety or major property is in immediate jeopardy. No new levees should be constructed under this maintenance action.

2) Work should be coordinated with Department/Service to protect sensitive habitats, i.e., bald eagle nest sites, spring creek tributaries.

3) All channel blocks constructed to prevent avulsion damage should be coordinated with the Department/Service and removed if they are determined to have an adverse impact on fish and wildlife resources.

4) Fish and wildlife impacts associated with emergency actions should be mitigated.

e. Quarry site

1) We do not believe it is appropriate at this time to develop mitigation packages until the number of sites has been limited to one or two. Based on our analysis, the preferred quarry alternative would be Teton Pass followed by the Phillips Ridge and Walton sites.

LITERATURE CITED

Annear, T. 1989a. Snake River instream flow studies. Administrative Report. Wyoming Game and Fish Department, Fish Division, Cheyenne, Wyoming.

________. 1989b. Snake river levee fisheries resource analysis. Unpublished Report. Prepared for the U.S. Fish and Wildlife Service. Wyoming Game and Fish Department, Cheyenne, Wyoming. 3pp.

Aune, K., T. Stivers, and M. Madel. 1984. Rocky Mountain Front grizzly bear monitoring and investigation. Montana Department of Fish, Wildlife and Parks Program Report. Helena, Montana. 239pp.

Baxter, G.T. and M.D. Stone. 1980. Amphibians and reptiles of Wyoming. Wyoming Game and Fish Department. 137pp.

Bernard, D. 1989. Personal communication. U.S. Department of Interior, National Park Service, Grand Teton National Park, Jackson, Wyoming.

Bilby, R.E., and J.W. Ward. 1989. Changes in characteristics and function of woody debris with increasing size of streams in Western Washington. Transaction of the American Fisheries Society. 118:368-378.

Block, W.M., L.A. Brennan, and R.J. Gutierrez. 1986. The use of guilds and guild indicator species for assessing habitat suitability. Pages 109-113 in J. Verner, M.L. Morrison, and C.J. Ralph, (eds.). Wildlife 2000, modeling habitat relationships of terrestrial vertebrates. University of Wisconsin Press, Madison, Wisconsin.

Blum, J.L. 1956. The ecology of the river algae. Botanical Review. 22(5): 291-341.

Bradley, J. 1989. Personnel communication. Teton County Planning Department.

Brinson, M.M., B.L. Swift, R.C. Plantico, and J.S. Barclay. 1981. Riparian ecosystems: their ecology and status. U.S. Fish and Wildlife Service Office, Biological Service. Publication FWS/OBS 81-17. 155pp.

Clark, T.W., and M.R. Stromberg. 1987. Mammals in Wyoming. University of Kansas Press Publication. Lawrence, Kansas. 314pp.

__________. 1981. Ecology of Jackson Hole, Wyoming, a primer. Paragon Press. Salt Lake City, Utah.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Office of Biological Services. Fish and Wildlife Service, U.S. Department of the Interior. Washington D.C.

Crouch, G.L. 1979. Changes in the vegetation complex of a cottonwood ecosystem on the South Platte River. Pages 19-22. In riparian and wetland habitats of the Great Plains: Procedures of the 31st annual meeting. Great Plains Agricultural Council. Fort Collins, Colorado.

Erickson, J. 1980. Give them gravel. Wyoming Wildlife 44(5): 30-34.

Finch, D.M. 1989. In Press. In R.P. Sharitz and J.W. Gibbons, (eds.). Proceedings freshwater wetlands and wildlife, perspectives on natural, managed and degraded ecosystems. Savannah River Ecology Laboratory, University of Georgia. Aiken, South Carolina.

__________. 1986. Similarities in riparian bird communities among elevational zones in southeastern Wyoming. Pages 105-110. In D.J. Brosz and J.D. Rogers, (eds.). Wyoming water and streamside zones conference, held April 28-30, 1986, Casper, Wyoming. Wyoming Water Resources Center, University of Wyoming, Laramie, Wyoming.

Fralick, G. 1989. Snake river levee system and general effects on terrestrial resources of the Snake river ecosystem. Unpublished Report. Prepared for the U.S. Fish and Wldlife Service. Wyoming Game and Fish Department, Cheyenne, Wyoming. 26pp.

Fryxell, F.M. 1980. Glacial features of Jackson Hole, Wyoming. Augustana Library Publication No. 13. 129pp.

Haible, W.W. 1976. Snake River flooding. In R.H. Twiss, L.B. Leopold, R. Ablondy, and R. Dunblazier, (eds.). Teton County Growth and Development Alternatives. Livingston and Associates. Jackson, Wyoming.

Harmata, A. 1989. Bald eagle movement and habitat use. Job Completion Report. Wyoming Game and Fish Department. Unpublished Report.

Hayden, S. 1989. Personal communication. Grand Teton National Park.

Hayden, P.S. 1967. The reproductive behavior of the Snake River cutthroat in three tributary streams in Wyoming. Wyoming Game and Fish Commission. Cooper Resource Project 4. 105pp.

Houston, D.B. 1968. The shiras moose in Jackson Hole, Wyoming. Grand Teton National Historical Association Technical Bulletin No. 1. 110pp.

Kiefling, J.W. 1984. Restoration of a spring creek. In F. Richardson and R.H. Hamre, (eds.). Wild Trout III. Proceedings of the Symposium, Yellowstone National Park. September 24-25, 1984.

__________. 1981. Jackson Lake completion report. Wyoming Game and Fish Department. Cheyenne, Wyoming. Report F-01-R.

__________. 1978. Studies on the ecology of the Snake River cutthroat trout. Fisheries Technical Bulletin No. 3. Federal Aid Report F-37-R. Wyoming Game and Fish Department, Cheyenne, Wyoming.

Kroger, R.L. 1967. A study of the classification and ecology of the aquatic invertebrates in the Snake River, Grand Teton National Park. Master's Thesis, University of Wyoming, Laramie, Wyoming. 161pp.

Land Management Services. 1981. Vegetation analysis, Tucker mine permit, Clark's construction, Jackson, Wyoming. Department of Environmental Quality, Land Quality Division, Jackson, Wyoming. 28pp.

Levine, E. 1988. Peregrine falcon productivity in the Greater Yellowstone Ecosystem. 1988. Unpublished Report. Prepared for The Peregrine Fund, Incorporated. 120pp.

Lockman, D. 1986. Waterfowl completion report. Wyoming Department of Game and Fish. Cheyenne, Wyoming.

__________, C. Rowland, and R. Drewein. 1985. Wyoming sandhill crane and whooping crane progress report. Wyoming Department of Game and Fish. Cheyenne, Wyoming.

Montopoli, G. 1987. A guide for the computer implementation of the cumulative effects model. Unpublished Report. Department of Statistics, University of Wyoming. 50pp.

Oakleaf, B. 1989. Snake river levee system and general effects on non-game and endangered species of the Snake river ecosystem. Unpublished Report. Prepared for the U.S. Fish and Wildlife Service. Wyoming Game and Fish Department, Lander, Wyoming. 22pp.

Phillips, C. 1987. Jackson Hole Fishery Resources: Economic implications of management alternatives. Unpublished Report. Prepared for the Sportsmen's Group. Jackson Hole Alliance for Responsible Planning. 79pp.

Ray, W.D. 1984. Fish and Wildlife Coordination Act Report and Supplements: Jackson Lake safety dams study, Minidoka Project, Wyoming-Idaho. Prepared for the Bureau of Reclamation. U.S. Fish and Wildlife Service, Division of Ecological Services and Boise Field Office, Boise, Idaho.

Rudd, W., L. Forrest, F. Lindsey, and S.W. Buskirk. 1986. River otters in Wyoming: distribution, ecology and potential impacts from energy development. Wyoming Cooperative Resource Unit, University of Wyoming. Unpublished Report. 86-02.

Severinghaus, W.D. 1981. Guild theory development as a mechanism for assessing environmental impact. Environmental Management. 5:187-190.

Simpson, P.W., J.R. Newman, M.A. Keirn, R.M. Matter, and P.A. Guthrie. 1982. Terrestrial and riparian systems. In Manual of Stream Channelization Impacts on Fish and Wildlife. U.S. Fish and Wildlife Service. Office Biological Services Publication FWS/OBS 82-24.

Simpson, J.C., and R.L. Wallace. 1982. Fishes of Idaho. University Press of Idaho. Moscow, Idaho.

Snyder, J. 1980. Draft. The functional dynamics of cottonwood-willow riparian ecosystems. Pages 10-40. In Managers' handbook for lowland river and stream riparian habitat (Draft).

Swenson, J.E., K.L. Alt, and R.L. Eng. 1986. Ecology of bald eagles in the Greater Yellowstone Ecosystem. Wildlife Monograph No. 95. 46pp.

Thomas, J.W., C. Maser and J.E. Rodick. 1980. Wildlife habitats in managed rangelands - the great basin of southeastern Oregon riparian zones. U.S. Department of Agriculture, Forest Service, Pacific Northwest Forests and Range Experimental Station General Technical Report PNW-8.

Twiss, R.H., L.B. Leopold, R. Ablondi and R. Dunblazier. 1976. Teton County growth and development alternatives. Livingston and Associates, Jackson, Wyoming.

U.S. Army Corps of Engineers. 1989. Draft environmental assessment. Jackson Hole Snake-Gros Ventre Rivers debris clearance project, Wyoming. Corps of Engineers, Walla Walla District, Walla Walla, Washington.

U.S. Army Corps of Engineers. 1989b. Draft environmental impact statement. Jackson Hole, Wyoming, flood protection project. Corps of Engineers, Walla Walla District, Walla Walla, Washington.

U.S. Bureau of Reclamation. 1984. Environmental impact statement. Jackson Lake safety of dams project, Wyoming-Idaho. Pacific Northwest Region, Boise, Idaho.

U.S. Department of the Interior. 1984. Final environmental impact statement: Jackson Lake safety of dams project. U.S. Department of Interior, Bureau of Reclamation, Pacific Northwest Region and National Park Service. Rocky Mountain Region, Boise, Idaho.

U.S. Fish and Wildlife Service. 1988. Preliminary biological evaluation: Wyoming Snake River and Spring Creeks levees. Prepared for the U.S. Army Corps of Engineers, Walla Walla District. U.S. Department of Interior, Fish and Wildlife Service, Boise, Idaho.

________________. 1986. Pacific bald eagle recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon. 160pp.

________________. 1979. Grizzly bear recovery plan. U.S. Fish and Wildlife Service, Denver, Colorado. 195 pp.

U.S. Forest Service. 1988. Draft Bridger-Teton land and resource management plan. U.S. Department of Agriculture, Forest Service, Bridger-Teton National Forest, Jackson, Wyoming.

Verner, J. 1984. The guild concept applied to management of bird populations. Environmental Management 8:1-14.

Wiley, R.W. 1969. An ecological evaluation of the Snake River cutthroat fishery with emphasis on harvest. University of Wyoming, Laramie, Wyoming. Cooperative Research Project 4. 106pp.

Wyoming Game and Fish Department. 1988. District 1 annual big game herd unit report. Cheyenne, Wyoming. 501 pp.

APPENDICES

WYOMING GAME AND FISH DEPARTMENT

Mike Sullivan, *Governor* Francis Petera, *Director*

April 9, 1990

EIS 5225
U.S. Army Corps of Engineers
Jackson Hole Flood Protection
Project
Snake River Levees
SIN: 89-098
Teton County

Ron Starkey
United States Department of the Interior
Fish and Wildlife Service
Fish and Wildlife Enhancement
2617 E. Lincolnway, Suite A
Cheyenne, WY 82001

Dear Mr. Starkey:

The staff of the Wyoming Game and Fish Department has reviewed the Fish and Wildlife Coordination Act Report (CAR) jointly prepared by the U.S. Fish and Wildlife Service and the Wyoming Game and Fish Department. We concur with the information and findings presented in the CAR.

We appreciate your cooperation on this project.

Sincerely,

Francis Petera

FRANCIS PETERA
DIRECTOR

FP:SCT:as
cc: Game Div.
Fish Div.
HATS Div.
SPC.

Appendix 2 A list of common and scientific names of plants in the Snake River drainage, Jackson Hole, Wyoming (adapted from Houston (1968) and Kiefling (1978)).

Common Name	Scientific Name
Agoseris	*Agoseris spp.*
Antelope Bitterbrush	*Purshia tridentata*
Arnica	*Arnica cordifolia*
Arrowleaf Balsamroot	*Balsamorhiza sagittata*
Aspen (Quaking)	*Populus tremuloides*
Aster	*Aster spp.*
Balsam Poplar	*Populus balsamifera*
Balsamroot	*Balsamorrhiza sagittata*
Bearberry	*Arctostaphylos uva-ursi*
Biscuitroot	*Lomatium spp.*
Bitterbrush	*Purshia tridentata*
Bluegrass	*Poa spp.*
Bluejoint Reedgrass	*Calamagrostis canadensis*
Blue Spruce	*Picea pungens*
Bog Birch	*Betula glandulosa*
Bog Bluegrass	*Poa leptocoma*
Bromegrass	*Bromus spp.*
Buttercup	*Ranunculus spp.*
Chara	*Chara sp.*
Cheatgrass	*Bromus tectorum*
Chokecherry	*Prunus virginiana*
Cinquefoil	*Potentilla spp.*
Cinquefoil, Shrubby	*Potentilla fruticosa*
Clover	*Trifolium spp.*
Cow parsnip	*Heracleum lanatum*
Cudweed	*Gnaphalium spp.*
Dandelion	*Taraxacum spp.*
Dogwood	*Cornus spp.*
Douglas Fir	*Pseudotsuga menziesii*
Douglas Rabbitbrush	*Chrysothamnus viscidiflorus*
Dwarf Huckleberry	*Vaccinium scoparium*
Duckweed, Star	*Lemna triculca*
Elk Thistle	*Cirsium foliosum*
Elk Sedge	*Carex geyeri*
Engelmann Spruce	*Picea engelmannii*
Eriogonum	*Eriogonum spp.*
Fireweed	*Epilobium angustifolium*
Fleabane	*Erigeron spp.*
Foxtail Muhly	*Muhlenbergia anadina*
Fringed Brome	*Bromus ciliatus*
Geranium	*Geranium spp.*
Geranium, Sticky	*Geranium viscosissimum*
Gilia	*Gilia spp.*

Appendix 2 (continued).

Common Name	Scientific Name
Gooseberry	*Ribes spp.*
Grouse (Big) Whortberry	*Vaccinium scoparium*
Green Algae	*Spirogyra spp., Zygnema spp.,* and others
Heartleaf	*Arnica cordifolia*
Hippuris, Mare's Tail	*Hippuris vulgaris*
Hornwort	*Ceratophyllum demersum*
Horsetail	*Equisetum fluviatile*
Idaho Fescue	*Festuca idahoensis*
Indian Ricegrass	*Oryzopsis lymenoides*
Junegrass	*Koeleria cristata*
Knotweed	*Polygonum spp.*
Kentucky Bluegrass	*Poa pratensis*
Lambsquarters	*Chenopodium spp.*
Large Huckleberry	*Vaccinium membranaceum*
Limber Pine	*Pinus flexilis*
Lodgepole Pine	*Pinus contorta*
Lupine	*Lupinus spp.*
Manngrass	*Glyceria spp.*
Meadow Barley	*Hordeum brachyantherum*
Menziesia	*Menziesia ferruginea*
Monkey Flower	*Mimulus glabratus*
Mountain Alder	*Alnus incana*
Mountain Ash	*Sorbus scopulina*
Mountain Lover	*Pachistima myrsinites*
Mountain Maple	*Acer glabrum*
Myriophyllum, Water Milfoil	*Myriophyllum sp.*
Narrowleaf cottonwood	*Populus angustifolia*
Needlegrass	*Stipa spp.*
Northern Bedstraw	*Galium boreale*
Oniongrass, Showy	*Melica spectabilis*
Pachystima	*Pachystima myrsinites*
Paintbrush	*Castilleja sp.*
Penstemon	*Penstemon spp.*
Pepperweed	*Lepidium spp.*
Phacelia	*Phacelia spp.*
Pinegrass	*Calamagrostis rubescens*
Pondweed	*Potamogeton spp.*
Pondweed, Leafy	*Potamogeton foliosus*
Pondweed, Needleleaf	*Potamogeton filiformes*
Prickly Lettuce	*Lactuca integrata*
Pullup Muhly	*Muhlenbergia filiformis*
Pussytoes	*Antennaria sp.*
Red Osier Dogwood	*Cornus stolonifera*
Redtop	*Agrostis alba*
Rocky Mountain Buttercup	*Ranunculus populago*
Rose	*Rosa woodsii*
Rush	*Juncus sp.*

Common Name	Scientific Name
Russet Buffaloberry	*Shepherdia canadensis*
Sagebrush	*Artemisia spp.*
Sagebrush, Big	*Artemisia tridentata*
Sagebrush, Low	*Artemisia arbuscula*
Sedge	*Carex spp.*
Sedge, Geyer's	*Carex geyeri*
Serviceberry	*Amelanchier alnifolia*
Shortawn Foxtail	*Alopecurus aequalis*
Silverberry	*Eleagnus commutata*
Snowberry	*Symphoricarpos spp.*
Snowbush Ceanothus	*Ceanothus velutinus*
Starry Solomon Plume	*Smilacina stellata*
Strawberry	*Fragaria spp.*
Subalpine Fir	*Abies lasiocarpa*
Tall Larkspur	*Delphinium occidentale*
Thimbleberry	*Rubus parviflorus*
Thinleaf Alder	*Alnus tenuifolia*
Threetip Sagebrush	*Artemisia tripparlita*
Timothy, Alpine	*Phleum alpinum*
Timothy	*Phleum pratense*
Tufted Hairgrass	*Deschampsia caespitosa*
Twinflower	*Linnaea borealis*
Utah Honeysuckle	*Lonicera utahensis*
Valeriana	*Valeriana spp.*
Violet	*Viola spp.*
Watercress	*Rorippa nasturtium-aquaticum*
Waterleaf	*Hydrophyllum capitatum*
Watercrowfoot	*Ranunculus aquatilis*
Wheatgrass	*Agropyron spp.*
Wheatgrass, Bluebunch	*Agropyron spicatum*
Wild Buckwheat	*Eriogonum spp.*
Wheatgrass, Slender	*Agropyron trachycaulum*
Wheatgrass, Western	*Agropyron smithii*
Whitebark Pine	*Pinus albicaulis*
Willow Dock	*Rumex salicifolius*
Willow	*Salix spp.*
Willow, Bebb	*Salix bebbiana*
Willow, Blueberry	*Salix pseudocordata*
Willow, Geyer's	*Salix geyeriana*
Willow, Interior	*Salix interior*
Willow, Myrtle-leaved	*Salix myrtillifolia*
Willow, Scouler's	*Salix scouleriana*
Willow, Whiplash	*Salix lasiandra*
Willow, Wolf's	*Salix wolfii*
Willow, Yellow	*Salix lutea*
Yarrow	*Achillea lanulosa*
Yellow Cowlily	*Nuphar polysepalum*
Yellow Sweetclover	*Melilotus officinalis*

Appendix 3

AVIAN SPECIES OCCURRING IN THE COTTONWOOD-RIPARIAN AND ASSOCIATED WETLAND HABITAT TYPES ALONG THE SNAKE RIVER IN THE JACKSON VICINITY (OAKLEAF 1989).

	SEASONAL[1] STATUS	ATLAS[2] STATUS	JACKSON[3] STATUS
Double-crested cormorant	S	B	S
Great blue heron [a,b]	S	B	S
Green-backed heron	M	O	M
Trumpeter swan [a,b]	R	B	M/W
Canada goose [b]	R	B	M
Wood duck [b]	S	O	S
Green-winged teal [b]	R	B	R
Mallard [b]	R	B	R
Northern Pintail [b]	R	B	M/W
Blue-winged teal [b]	S	B	S
Cinnamon teal [b]	S	B	S
Northern shoveler [b]	S	B	S
Gadwall [b]	R	B	R
American wigeon [b]	R	B	R
Redhead [b]	S	b	M
Ring-necked duck [b]	S	B	M
Lesser scaup [b]	S	B	M
Harlequin duck [b]	S	B	M
Common goldeneye [b]	R	B	M/W
Barrow's goldeneye [b]	R	B	R
Bufflehead [b]	R	B	M/W
Hooded merganser [b]	R	O	R
Common merganser [b]	R	B	R
Ruddy duck	S	B	M
Turkey vulture	S	B	S
Osprey [b]	S	B	S
Bald eagle [a,b]	R	B	R
Sharp-shinned hawk [b]	S	B	S
Cooper's hawk [b]	S	B	S
Northern goshawk	R	B	R
Broad-winged hawk	M	O	M
Swainson's hawk	S	B	S
Red-tailed hawk	R	B	R
Ferruginous hawk [a]	R	B	M
Golden eagle	R	B	R
American Kestrel	S	B	S
Merlin [a]	R	b	R
Peregrine falcon [a,b]	R	B	R
Prairie falcon	R	B	R
American coot	S	B	S
Killdeer	S	B	M
Spotted sandpiper	S	B	S
Mourning dove	S	B	S
Black-billed cuckoo	S	O	M
Yellow-billed cuckoo [a]	S	O	M

Appendix 3 continued.

AVIAN SPECIES OCCURRING IN THE COTTONWOOD-RIPARIAN AND ASSOCIATED WETLAND HABITAT TYPES ALONG THE SNAKE RIVER IN THE JACKSON VICINITY.

	SEASONAL[1] STATUS	ATLAS[2] STATUS	JACKSON[3] STATUS
Western screech-owl	R	b	R
Great horned owl	R	B	R
Long-eared owl	R	B	R
Northern saw-whet owl	R	b	R
Common nighthawk	S	B	M
Black-chinned hummingbird	S	O	S
Calliope hummingbird	S	B	S
Broad-tailed hummingbird	S	B	M
Rufous hummingbird	S	B	M
Belted kingfisher	R	B	R
Lewis' woodpecker [a]	S	b	S
Red-headed woodpecker	S	O	M
Red-naped sapsucker	S	B	S
Downy woodpecker	R	B	R
Hairy woodpecker [b]	R	B	R
Northern flicker	R	B	R
Olive-sided flycatcher	S	B	M
Western wood-pewee	S	B	S
Willow flycatcher [b]	S	B	M
Least flycatcher	S	O	S
Dusky flycatcher	S	B	S
Western flycatcher	S	b	M
Great crested flycatcher	A	O	M
Western kingbird	S	O	S
Eastern kingbird	S	O	S
Tree swallow	S	B	S
Violet-green swallow	S	B	S
Northern rough-winged swallow	S	B	S
Bank swallow	S	B	S
Cliff swallow	S	B	S
Barn swallow	S	B	S
Gray jay	R	b	M/W
Blue jay	R	O	M
Black-billed magpie	R	B	R
American crow	R	B	R
Common raven	R	B	R
Black-capped chickadee	R	B	R
Mountain chickadee	R	B	M/W
Red-breasted nuthatch	R	B	R
White-breasted nuthatch	R	B	R
Pygmy nuthatch	R	O	M/W
Brown creeper	R	B	M/W

Appendix 3 continued.

AVIAN SPECIES OCCURRING IN THE COTTONWOOD-RIPARIAN AND ASSOCIATED WETLAND HABITAT TYPES ALONG THE SNAKE RIVER IN THE JACKSON VICINITY.

	SEASONAL[1] STATUS	ATLAS[2] STATUS	JACKSON[3] STATUS
House wren	S	B	S
Winter wren	M	b	M
Marsh wren [b]	S	B	M
American dipper [b]	R	B	R
Golden-crowned kinglet	R	b	M/W
Ruby-crowned kinglet	S	B	M
Blue-gray gnatcatcher	S	O	M
Mountain bluebird	S	B	S
Townsend's solitaire	R	B	M/W
Veery [b]	S	b	S
Swainson's thrush [b]	S	B	S
Hermit thrush	S	B	M
American robin	R	B	R
Gray catbird	S	O	S
Northern mockingbird	S	O	M
Brown thrasher	S	O	S
Bohemian waxwing	W	O	W
Cedar waxwing	R	B	R
Northern shrike	W	O	W
Loggerhead shrike	S	b	S
European starling	R	B	R
Solitary vireo	S	O	M
Warbling vireo	S	B	S
Red-eyed vireo [b]	S	b	S
Tennessee warbler	M	O	M
Orange-crowned warbler	S	b	S
Nashville warbler	M	O	M
Virginia's warbler	S	O	M
Yellow warbler [b]	S	B	S
Chestnut-sided warbler	M	O	M
Black-throated blue warbler	M	O	M
Yellow-rumped warbler	S	B	S
Townsend's warbler	S	O	M
Blackburnian warbler	M	O	M
Palm warbler	M	O	M
Bay-breasted warbler	M	O	M
Black-and-white warbler	M	—	M
American redstart [b]	S	B	S
Ovenbird	S	—	M
Northern waterthrush	M	O	M
MacGillivray's warbler	S	B	S
Common yellowthroat	S	B	M
Wilson's warbler	S	B	M
Yellow-breasted chat	S	O	M
Summer tanager	S	O	M
Western tanager	S	B	S

Appendix 3 continued

AVIAN SPECIES OCCURRING IN THE COTTONWOOD-RIPARIAN AND ASSOCIATED WETLAND HABITAT TYPES ALONG THE SNAKE RIVER IN THE JACKSON VICINITY.

	SEASONAL[1] STATUS	ATLAS[2] STATUS	JACKSON[3] STATUS
Rose-breasted grosbeak	S	O	M
Black-headed grosbeak	S	B	S
Lazuli bunting	S	B	S
Indigo bunting	S	O	M
Rufous-sided towhee	S	O	S
American tree sparrow	W	O	W
Chipping sparrow	S	B	S
Clay-colored sparrow	S	B	M
Brewer's sparrow	S	B	M
Field sparrow	S	O	M
Vesper sparrow	S	B	M
Lark sparrow	S	O	M
Savannah sparrow	S	B	M
Fox sparrow	R	B	R
Song sparrow	R	B	R
Lincoln's sparrow	S	B	M
White-throated sparrow	M	O	M
White-crowned sparrow [b]	S	B	S
Harris' sparrow	W	O	W
Dark-eyed junco	R	B	M/W
Rusty blackbird	M	O	M
Brewer's blackbird	S	B	S
Common grackle	S	O	S
Brown-headed cowbird	S	B	S
Northern oriole	S	B	S
Pine grosbeak	R	b	W
Cassin's finch	R	B	M/W
House finch	R	b	M/W
Pine siskin	R	B	M/W
American goldfinch	R	B	R
Evening grosbeak	R	B	R

[1] Statewide seasonal status as given in Oakleaf et al. (1982).
[2] Occurrence in degree block 8 (Oakleaf et al. 1982) where O is observed only, b is probable breeding, B is documented breeding, and _ is not observed in this degree block.
[3] Seasonal status specifically for cottonwood-riparian in degree block 8.
[a]/ Nongame Priority Species (WGFD, 1987)
[b]/ Habitat suitability for these species has been negatively impacted by the levee system and/or will be degraded without special management attention to commensate for future trends.

endix 4.

NONGAME MAMMAL AND FURBEARER SPECIES OCCURRING IN THE COTTONWOOD - RIPARIAN AND ASSOCIATED WETLAND HABITAT TYPES ALONG THE SNAKE RIVER IN THE JACKSON VICINITY (OAKLEAF 1989)

NONGAME MAMMALS	ATLAS STATUS LATILONG 8[1]	SNAKE RIVER STATUS[2]
Masked Shrew	B	C
Dusky Shrew	B	C
Vagrant Shrew	h	U
Water Shrew	B	C
Little Brown Myotis	0	C
Long-legged Myotis	0	C
Long-eared Myotis	0	C
Silver-haired Bat	h	P
Hoary Bat	0	P
Least chipmunk	B	C
Yellow-bellied Marmot	B	C
Wyoming Ground Squirrel	B	P
Uinta Ground Squirrel	B	C
Golden-mantled Ground Squirrel	B	C
Red Squirrel	B	C
Northern Pocket Gopher	B	C
Deer Mouse	B	C
Gapper's Red-backed Vole	B	C
Heather Vole	B	C
Meadow Vole	B	C
Montana Vole	B	C
Long-tailed Vole	B	C
Water Vole	B	C
Western Jumping Mouse	B	C
River Otter[a/]	B	C
Lynx[a/]	0	C
AQUATIC FURBEARERS		
Beaver	B	C
Muskrat	B	C
Long-tailed Weasel	B	C
Mink	B	C

[1] Documented occurrence in Latilong 8 (Findholt et al. 1981). 0 = observed only, h = historical occurrence, B = documented breeding

[2] Status in the Snake River corridor. P = probable occurrence, C = confirmed occurrence, U = unknown

[a/] Nongame Priority Species (WGFD, 1987) [b/] Habitat suitability for all species listed has been negatively impacted by the Levee System and/or will be degraded without special management attention to retain wetlands and riparian habitat.

Appendix 5. Wyoming Game and Fish Department management objectives for the South Park Wildlife Unit(Fralick 1989).

The South Park Habitat Unit

Introduction

The South Park Habitat Unit is located in Teton County approximately six miles south of Jackson (Figure 1). The unit lies along the north side of the Snake River and encompasses a total acreage of 1,197.96 acres. The Department first purchased 450 acres in 1939. In 1940 additional land was acquired through purchases and land trades.

The impetus to first acquire this land occurred in the late 1930's when elk damage on private lands in the Jackson area became a significant problem. This damage increased as winter habitat was lost due to development and elk were forced to forage on private lands. As a result of the habitat loss, major segments of the Jackson and Fall Creek elk herds were solely dependent upon supplemental feed during the winter.

The South Park Habitat Unit's highest management priority is that of an elk winter feedground. Public hunting, fishing, and other outdoor nonconsumptive use activities are also provided.

Goals and Objectives of the South Park Habitat Unit

Elk is the species of wildlife receiving management priority. However, lesser numbers of mule deer and moose also occupy the unit during the winter and early spring. In addition to big game species, the unit is inhabited by 53 other species (Tables 1 and 2) of wildlife which have been documented during seasonally important times of the year. During the fall and winter, hunters use the unit to pursue big game and waterfowl. Throughout the year fishermen use the area. Lastly, the unit is utilized by humans in a nonconsumptive use capacaity during periods other than the hunting season. To effectively meet the demands of the public and provide recreational opportunity in addition to providing crucial habitat requirements to wildlife, the Department established a series of goals and land use objectives with which to manage the unit. These mandates are provided below:

A. Primary Goal of the Unit

The South Park Habitat Unit was acquired as a partial fulfillment of the Department's goal to manage all Wyoming wildlife, and, in cooperation with other landowners and land management agencies, manage the habitat in such a manner that wildlife maintains densities and distribution consistent with the welfare of the resource, which will provide optimum sustained recreational, scientific, educational, aesthetic, and economic benefits to the public.

B. Management Objectives

1. Primary Objective - The primary objective is to provide a winter feedground for 1010 elk from four to five months annually (Table 3).

2. Secondary Objectives -

(a) To improve willow production and vigor along Flat Creek and the Snake River.

(b) Maintain and enhance existing wetlands on the habitat unit, and develop a minimum of 10-15 acres of shallow permanent palustrine wetlands including islands and maximize riverine aquatic bed habitat on the unit.

(c) To increase the publics' knowledge of the habitat area, its wildlife, and recreational value.

(d) To inventory nongame and small game species found on the unit and to determine habitat needs

3. Wildlife Management Objectives -

(a) Elk - maintain habitat to winter 1010 elk for 4 months to assist the Department's supplemental elk feeding program. Provide spring, summer, fall habitat to support 15 elk for 8 months.

(b) Moose - provide winter habitat to support 2 moose for 8 months.

(c) Mule Deer - provide winter habitat to support 100 mule deer for 4 months.

(d) Ducks - provide yearlong habitat to support 70 breeding pairs of ducks (emphasis on mallards, Barrow's goldeneyes, and teal).

(e) Canada geese - provide spring, summer, and fall habitat to support 10 breeding pairs of Canada geese.

(f) Trumpeter swans - provide yearlong habitat to support 2 nesting pairs of trumpeter swans and winter habitat for 25 wintering trumpeter swans.

(g) Sandhill cranes - provide spring, summer, and fall habitat to support 1 nesting pair of cranes.

(h) Raptors

(1) Bald eages - provide yearlong to support 1 nesting pair of bald eagles.

(2) Osprey - provide spring, summer, and fall habitat to support 1 nesting pair of ospreys.

(3) Other Raptors - provide spring, summer, and fall habitat to support 4 nesting pairs of various other raptor spp.

C. Consumptive and Nonconsumptive Use Objectives

1. Nonconsumptive Use - provide 12,000 mandays of quality nonconsumptive use 1990 (to include such activities as hiking, wildlife observation).

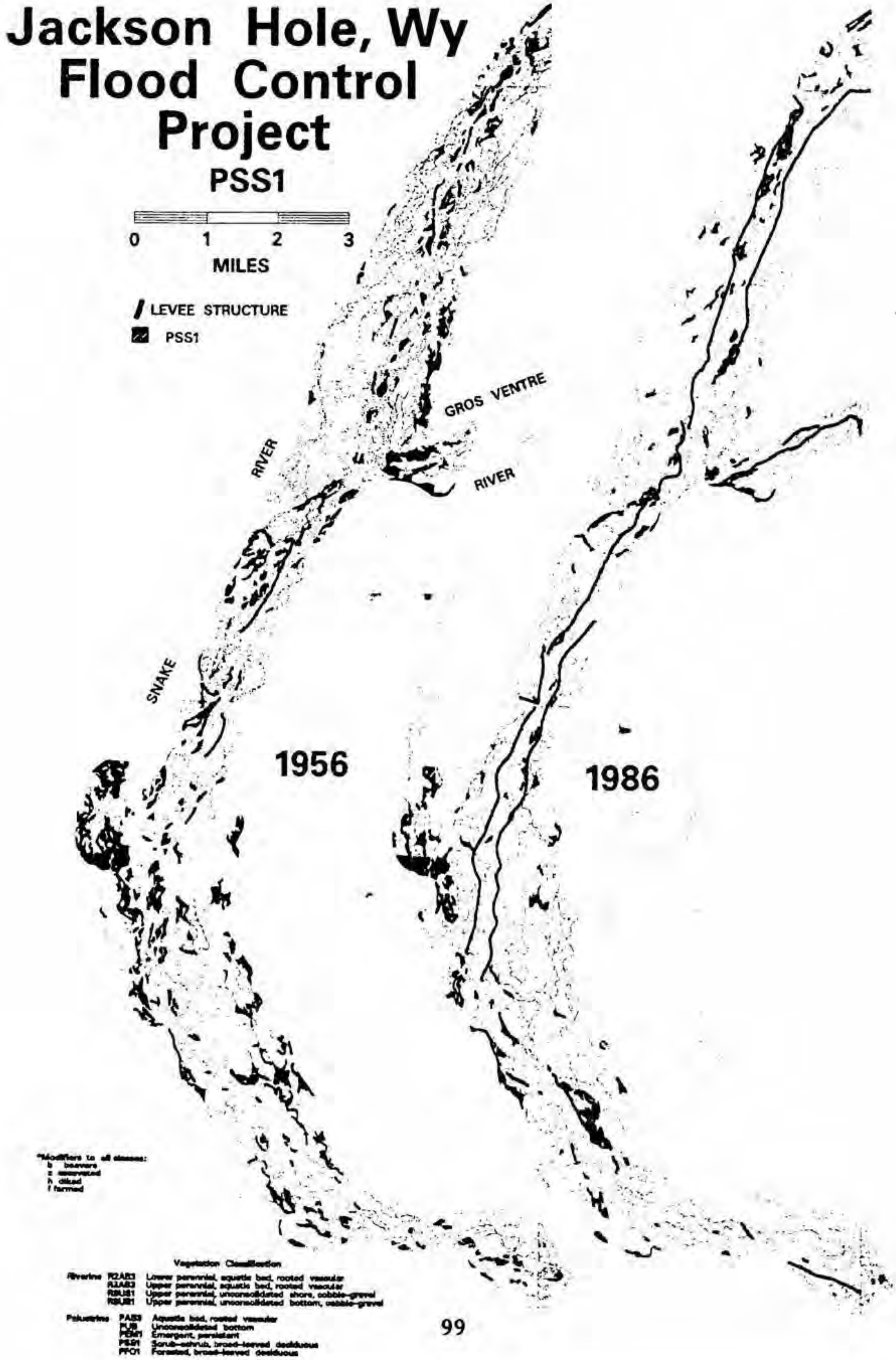
2. Consumptive Use - provide 800-1,000 mandays of fishing on Flat Creek (currently Flat Creek provides 600 fisherman days per year on the unit).

Nonconsumptive Uses

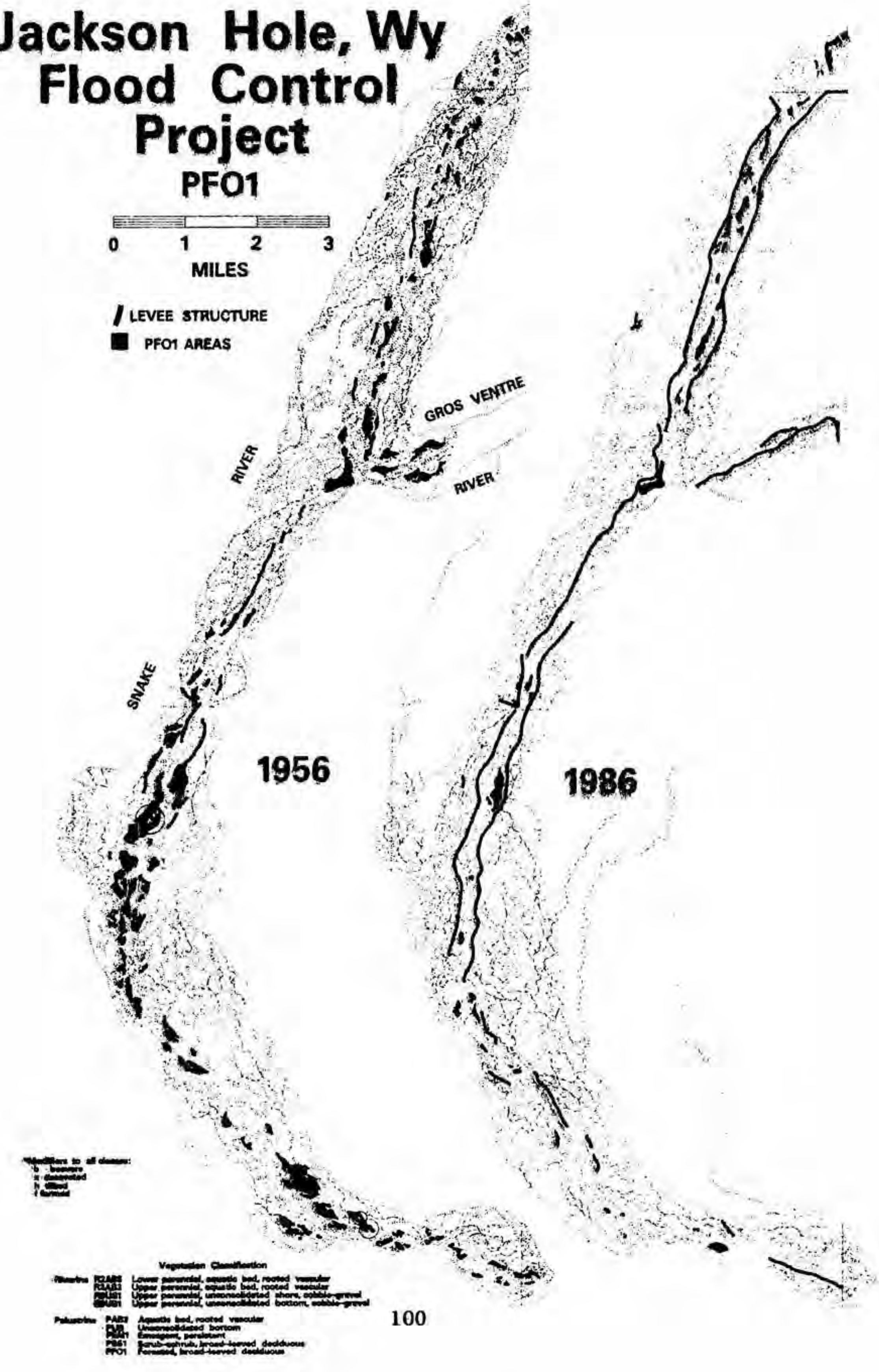
Close proximity of the unit to the city of Jackson ensures that the unit will be utilized by a significant proportion of visitors for a varied number of outdoor activities each year. Hiking, picnicking, and wildlife observation appear to be very important and popular uses of the unit. In order to document the extent of public use of the unit, a traffic counter was used from 1970-1976. During this period, from June 1 through September 10 annually, the number of vehicles averaged 3,641 per month. This count includes all forms of recreation except hunting. From September 11 through November 16, the number of vehicles averaged 15,102 per month and encompassed all forms of recreational uses, both concumptive and nonconsumptive. In addition, a small rifle range located on the unit receives a significant amount of use not documented by traffic counters.

During 1988 an estimated 5,000 mandays of nonconsumptive use occurred on the unit largely in the form of picnickers, overnight campers, and wildlife observation.

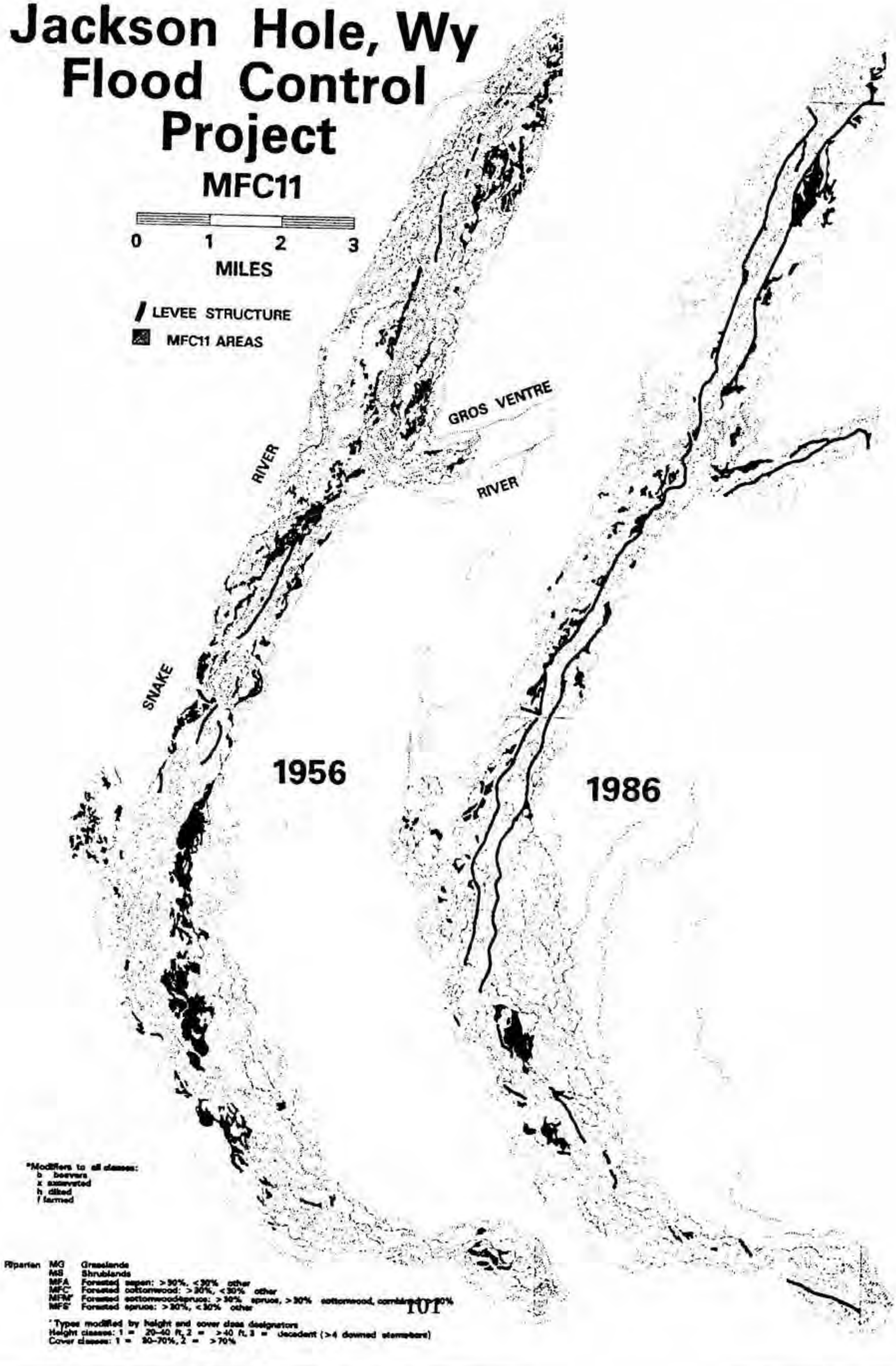
Appendix 6 a. Shrub vegetation distribution existing and prior to project construction.



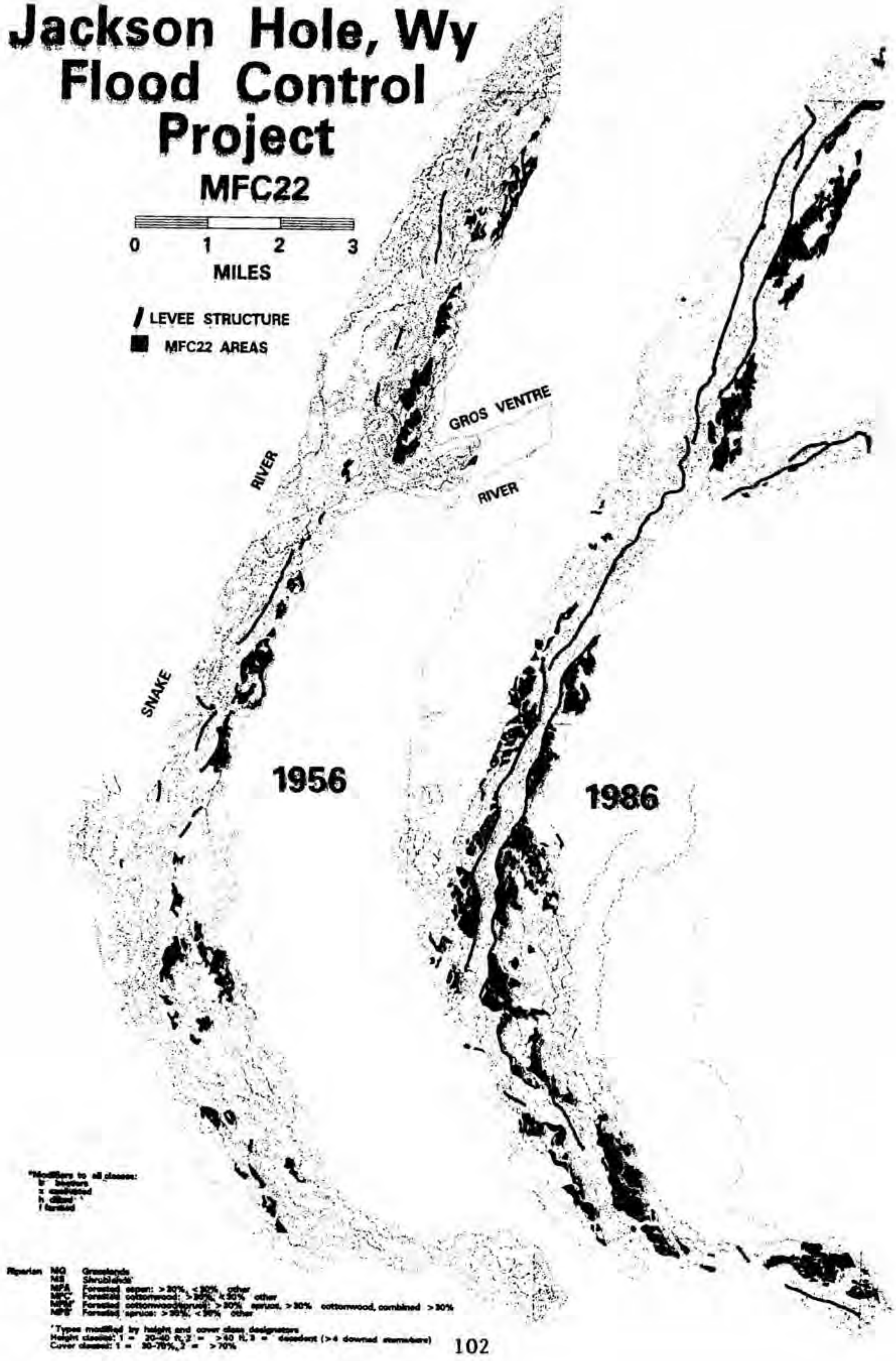
Appendix C 6. Regularly flooded forested cottonwood vegetation distribution existing and prior to project construction.



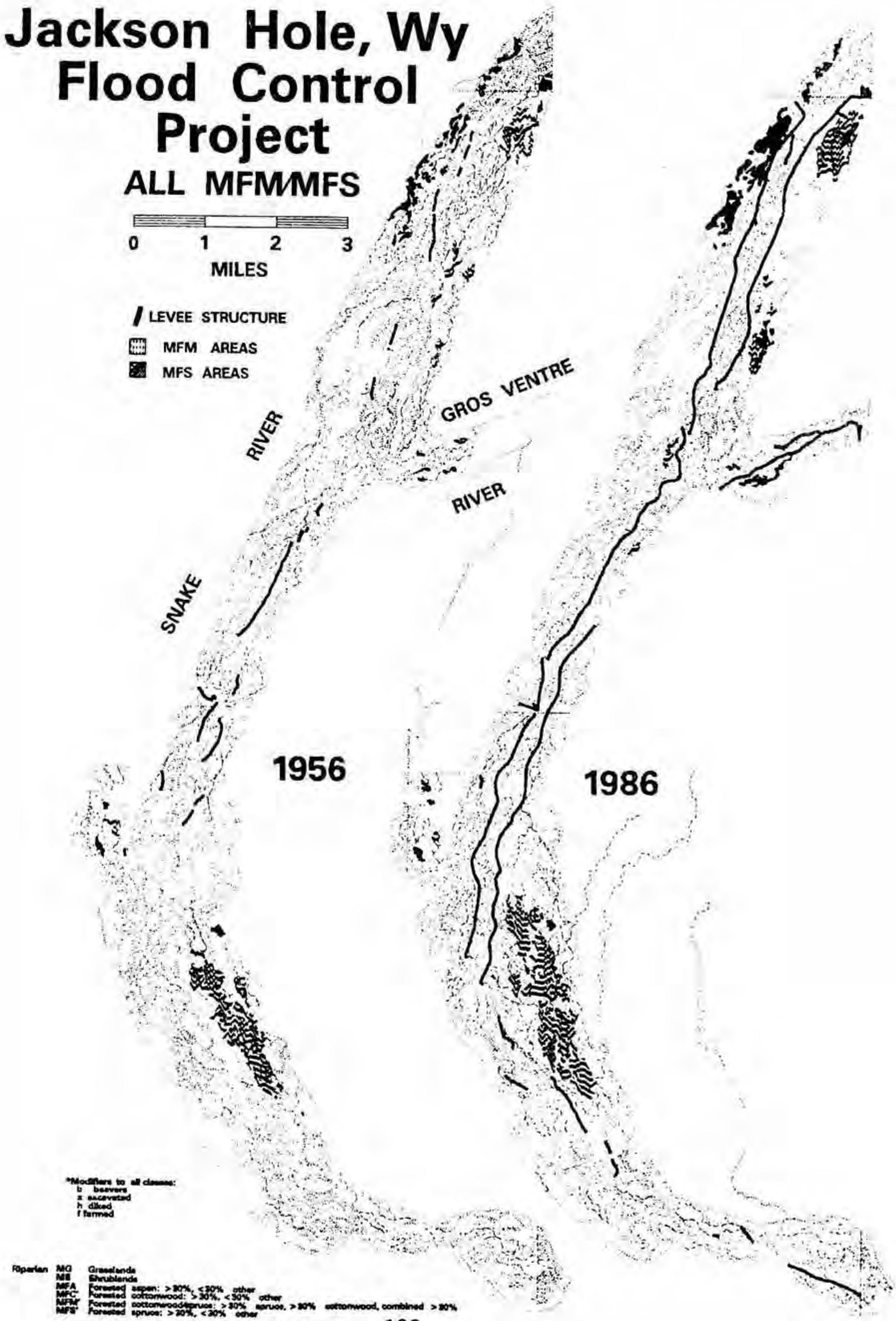
distribution existing and prior to project construction.



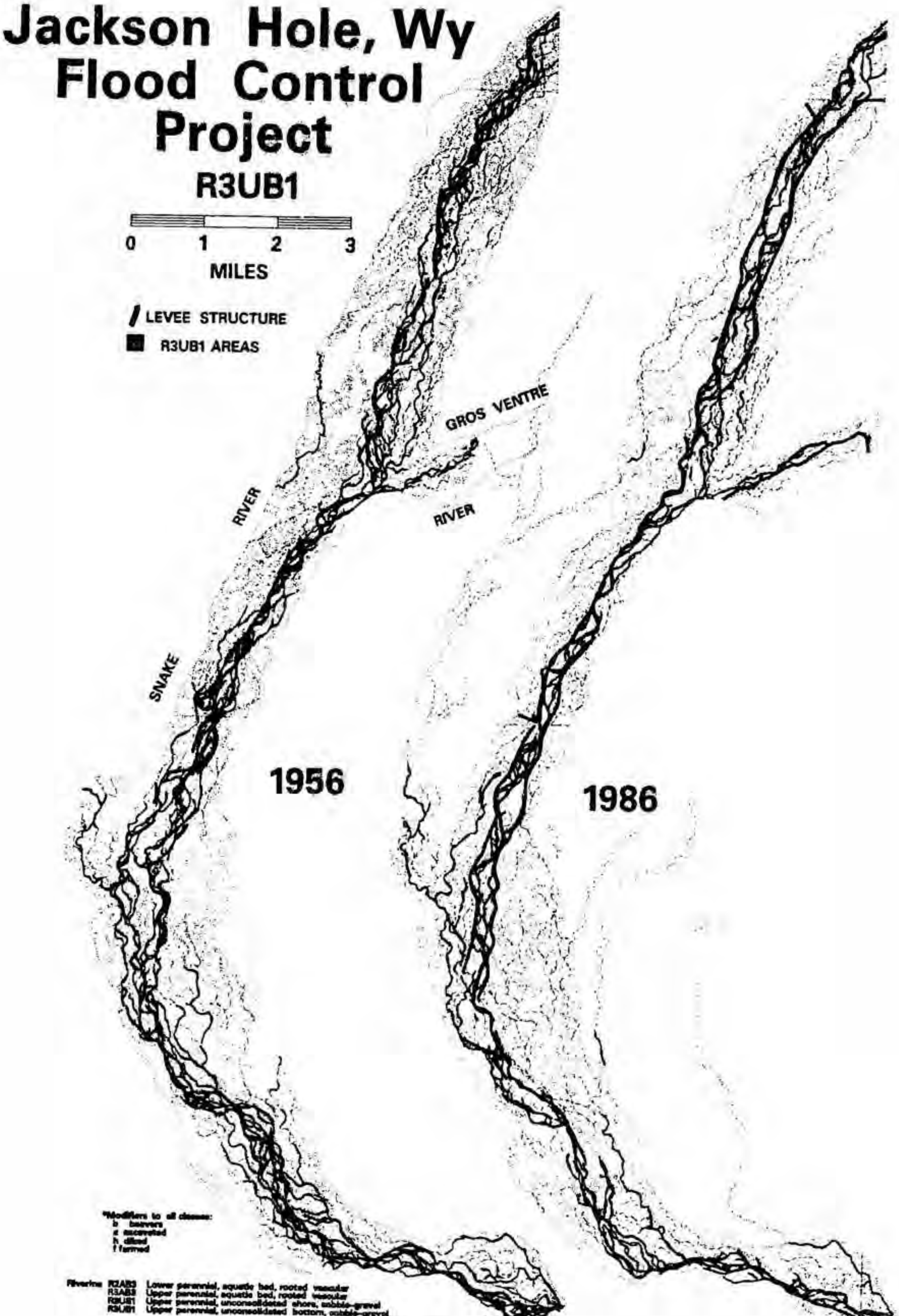
Appendix 6 d. **Infrequent to rarely flooded mature cottonwood vegetation distribution existing and prior to project construction.**



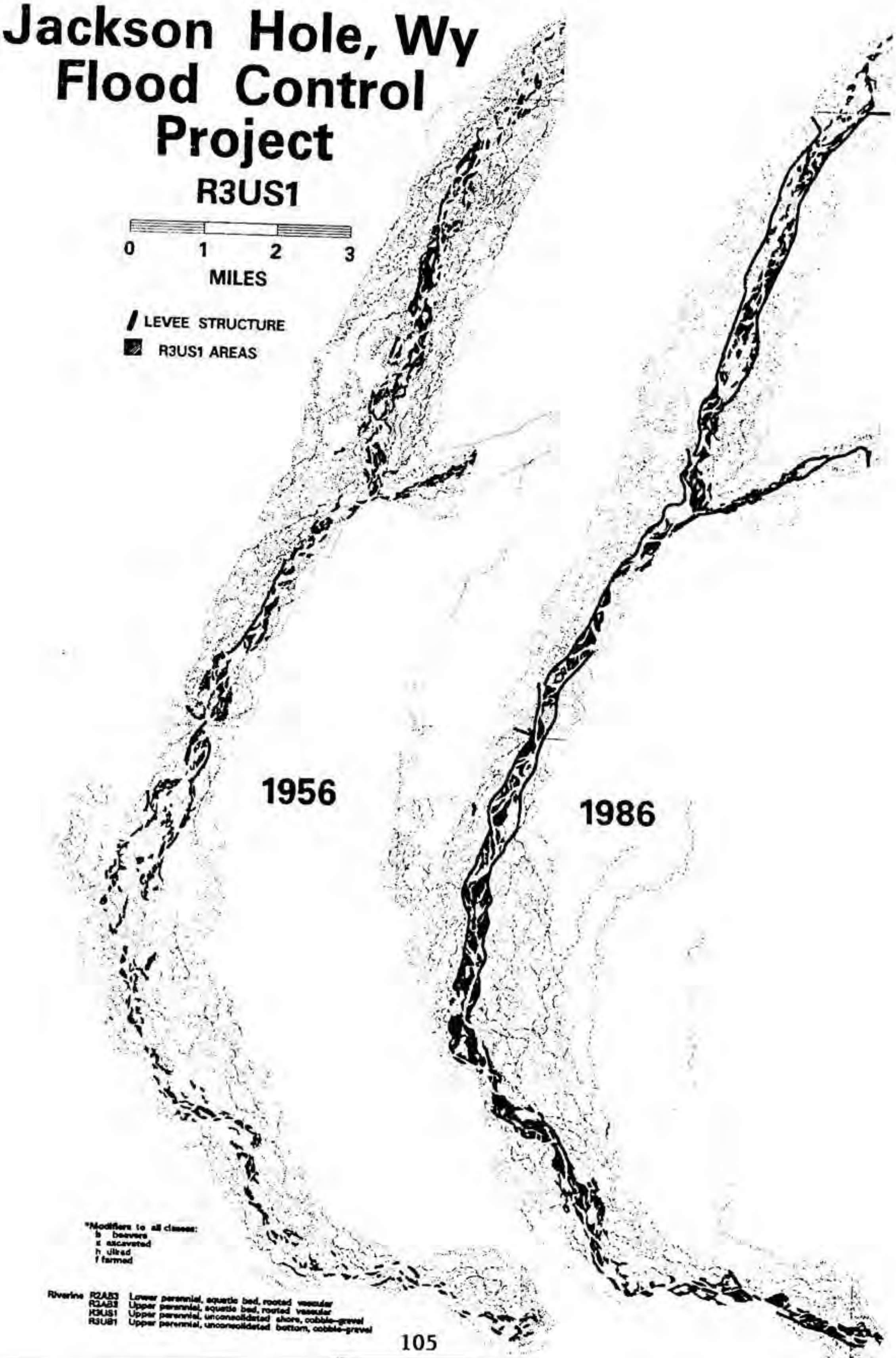
Appendix 6 e. **Mix cottonwood/spruce and spruce vegetation distribution existing and prior to project construction.**



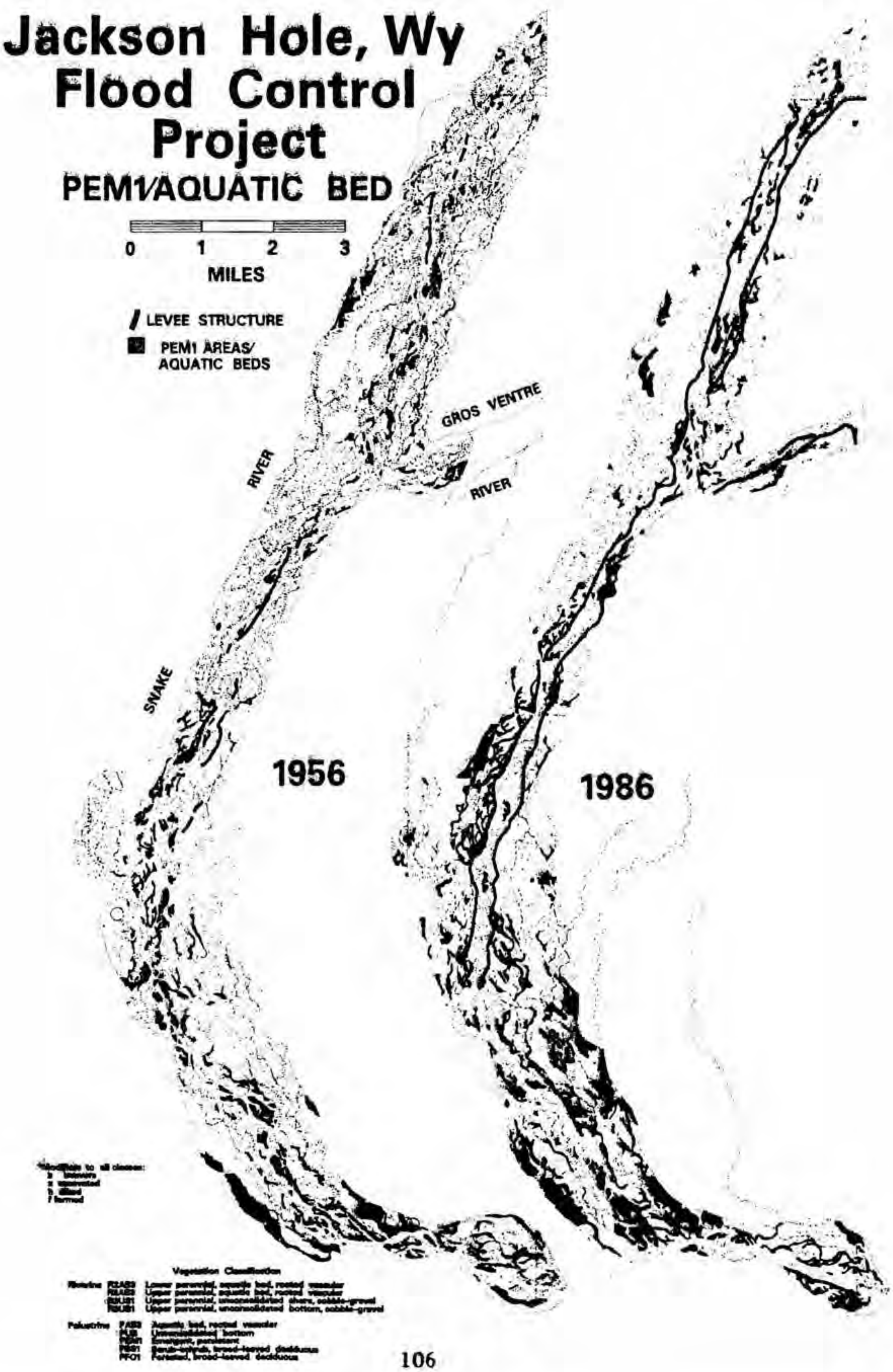
Appendix 6 f. **Unconsolidated stream bottom distribution existing and prior to project construction.**



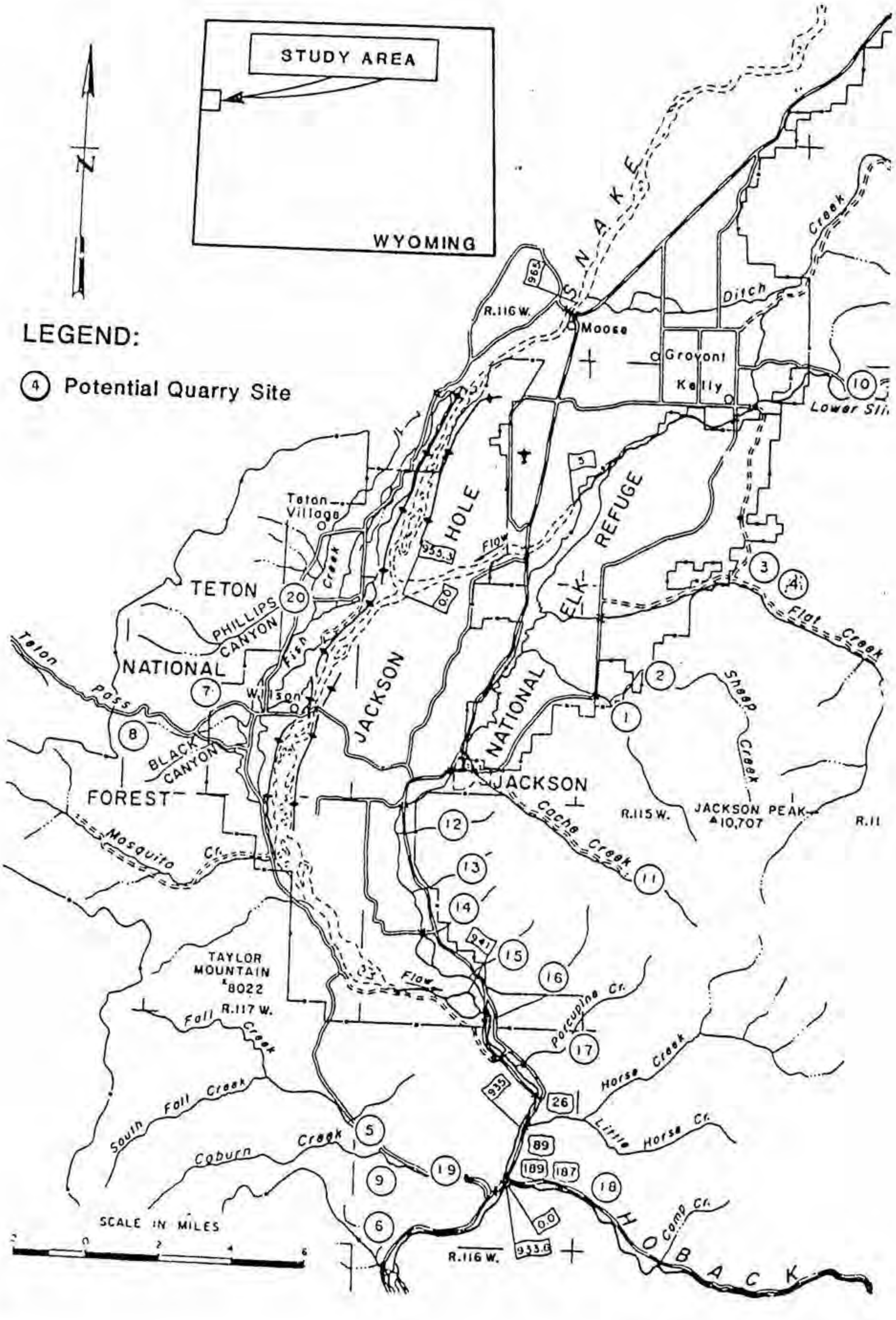
Appendix 6 g. **Unconsolidated stream shore distribution existing and prior to project construction.**



Appendix 6 h. **Emergent vegetation distribution existing and prior to project construction.**



Appendix 7.



Map of the study area illustrating the locations of the 20 potential quarry sites.

Appendix 7. (continued).

QUARRY SITE SUMMARIES.

SITE NO.	SITE NAME	LOCATION	ROCK TYPE	TYPE OF DEPOSIT
** 1	**Curtis Canyon**	**NE1/4 Sec.20, NW1/4 Sec.21, T.41N.,R.115W**	**Granite and Granite Gneiss**	**Outcrop**
2	Sheep Creek	NW1/4 Sec.16 T.41N.,R.115W.	Limestone	Outcrop
* 3	Flat Creek	SE1/4 Sec.35, and SW1/4 Sec.36, T.42N.,R.115W.	Basalt	Outcrop
* 4	Flat Cr. Talus	Sec.1, T.41N., R.115W.	Sandstone	Talus
* 5	Rock Creek	NW1/4 of SE1/4 Sec.13, T.39N., R.117W.	Sandstone	Talus
* 6	Pritchard Cr./ Dog Creek	NE1/4 Sec.31, T.39N.,R.116W.	Sandstone	Outcrop
* 7	Phillips Ridge	Sec.s 17 and 20, T.41N., R.117W.	Andesite	Outcrop
* 8	Teton Pass	SW1/4 Sec.19., T.41N., R.117W.	Granite/Granite Gneiss/ Sandstone	Outcrop
9	Coburn Cr./ Little Munger	NE1/4,NE1/4 Sec.30, T.39N., R.116W.	Sandstone	Outcrop
10	Gros Ventre Slide	Sec.6, T.42N, R.114W.	Sandstone	Landslide
11	Cache Creek	Sec.s 3,4,9,10,T.40N.,R.115W.	Limestone, sandstone, granite	Outcrop
12	Leeks Canyon	SE1/4,NW1/4, Sec.4 T.40N., R.116W.	Limestone	Outcrop
13	Smith Canyon	SE1/4,SE1/4, Sec.8, SW1/4, SW1/4, Sec.9, NE1/4, NE1/4, Sec.17, NW1/4, NW1/4, Sec. 16, T.40N., R.116W.	Limestone	Outcrop
14	Wilson Canyon	SE1/4, Sec.16, T.40N., R.116W.	Limestone	Outcrop
15	Horsethief Cyn.	NE1/4, SE1/4, Sec.22, T.40N., R.116W.	Limestone	Outcrop
16	Game Creek	SE1/4, SE1/4 Sec.26, T.40N., R.116W.	Limestone	Outcrop
17	Porcupine Cr.	Sec.31, T.40N., R.115W.	Limestone	Outcrop
18	Hoback Cyn.	Sec.30, T.39N., R.115W.	Sandstone	Outcrop
19	Fall Cr. Cyn.	SE1/4, SW1/4, Sec.21, T.39N., R.116W.	Sandstone	Outcrop
20	Phillips Cyn.	SE1/4, SE1/4, Sec.3, T.41N., R.117W.	Dolomite/Granite	Outcrop

* Laboratory tests include unit weight, specific gravity, and absorption.

** Laboratory tests include unit weight, specific gravity, absorption, LA abrasion, freeze-thaw, accelerated expansion, soundness, wet-dry, and magnesium sulfate.

Appendix 8.
National Elk Refuge Manager's June 12, 1989, letter to the Walla Wallla Corps' Districts pertaining to potential quarry development concerns on or near the National Elk Refuge.

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
NATIONAL ELK REFUGE
675 EAST BROADWAY
P.O. BOX C
JACKSON, WY 83001
June 12, 1989

Marvin G. Brammer, P.E.
Chief, Engineering Division
Department of the Army
Corps of Engineers
Walla Walla District
Walla Walla, WA 99362-9265

Dear Mr. Brammer:

We recently received a copy of the quarry site summaries, with the four preferred sites, from Art Anderson of the US Fish and Wildlife Service, Fish and Wildlife Enhancement Office in Cheyenne, Wyoming. We have objections to the construction of a quarry at Curtis Canyon Site 1 and Flat Creek Slide Site 4. Access to both of these sites would be across the National Elk Refuge and could cause considerable wildlife disturbance; would be a traffic hazard to refuge personnel, local residents and the visiting public; would create dust as well as maintenance problems on the dirt and gravel roads on the refuge.

The Curtis Canyon and Flat Creek Slide proposed quarry sites are all located immediately east of the National Elk Refuge (NER) on traditional big game winter range of the Bridger-Teton National Forest (BTNF). Those lands were administratively set aside as big game winter range by the US Forest Service in 1918 and livestock grazing was prohibited there.

Since 1966, public use of the winter range has been prohibited by the Forest Service from December 1 to April 30 each year to arrest human disturbance to wintering elk, big horn sheep, and mule deer. This action was taken in conjunction with closure of the NER road, 3.5 miles north of Jackson, that serves as access to the Curtis Canyon area of the BTNF. A 1.5-mile section of the road was closed to reduce disturbance to wintering elk and to enhance forage utilization on the refuge land adjacent to the road. The Curtis Canyon road, originating at the quarter section corner common to Sections 7 and 18, T41N, R115W (location of the Izaak Walton League sign) and running easterly 1.5 miles to the National Forest boundary, was constructed by the US Forest Service under Permit 46-459 issued in 1946 to the Teton Forest Supervisor. The permit designated a 24-foot wide right-of-way for construction of a road across the NER to access merchantable timber in Curtis Canyon and Sheep Creek of the Teton National Forest. Specific stipulations were attached to the permit, including:

> "The use of the lands of the United States hereby authorized shall always be subject to dominant use of the said premises by the United States in its control over game, fur-bearing animals and wild birds under applicable

Federal laws"; and "This permit, or any privilege given hereunder, is subject to the discretionary revocation by the issuing officer... whenever it shall be determine that the continued occupancy and use of the aforesaid lands for road purposes is incompatible with the purpose for which the reservation and refuge was established......"

The refuge road north of the Izaak Walton League sign to Flat Creek is also closed from December 1 to April 30 to protect wintering elk. Therefore, we would strongly oppose any quarrying or related activity at those quarry sites east of the NER during that time period. Furthermore, activity at either site would disturb and potentially displace wintering elk from winter range on the BTNF slopes onto the NER. This is contrary to objectives of the State and Federal agencies to reduce the need for supplemental feeding by encouraging good distributions of elk on native winter ranges.

Beyond our concerns about wildlife disturbance, we have serious reservations about allowing heavy trucks to haul across the refuge. All refuge roads are gravel and/or dirt. They would require considerable upgrading and maintenance to accommodate heavy trucks. Teton County maintains the road from the edge of Jackson to about 1/4 mile south of the Izaak Walton League sign. The NER maintains the road from that point northward 4.5 miles to the BTNF boundary. Under the aforementioned Special Use Permit, the Forest Service maintains the Curtis Canyon road from the Izaak Walton League sign to the Forest Service - Elk Refuge boundary (approximately 1.5 miles).

In addition to increased maintenance costs and deterioration of the roads, another concern is the safety of refuge personnel, local residents and visitors to the refuge. From the middle of December to the first of April this year, we had over 29,000 people visit our sleigh ride visitor center. During the same time period, we were feeding approximately 9,500 elk and had a 20-ton feed truck traveling the refuge road daily. During the spring, summer, and fall months various-sized motor homes, horse and travel trailers, and numerous other camp outfits travel the road to the BTNF. The road is not wide enough to accommodate a motor home or house trailer and a large truck without one of them having to pull over to let the other one pass. All year there are people using the road to walk, jog, ride bikes and horses, walk their dogs, etc. Large trucks would pose a threat to them because the road is so narrow.

We also are concerned with the dust that will be generated by the large trucks. Our shop area and refuge houses, where two refuge families reside, are located adjacent to the road. Excessive dust might also be detrimental to the vegetation growing near the road.

Thank you for considering our concerns about your proposed quarry sites.

Sincerely,

John E. Wilbrecht
National Elk Refuge Manager

cc: FWE, USFWS, Cheyenne, WY
BTNF, USFS, Jackson, WY
WGFD, Jackson, WY
R6/RW, USFWS, Denver, CO

Appendix 9.
United States Geological Survey's December 28, 1989, letter to the Wyoming State Supervisor, U. S. Fish and Wildlife Service, outlining study needs to address the project area.

United States Department of the Interior

GEOLOGICAL SURVEY

Water Resources Division
2617 E. Lincolnway, Suite B
Cheyenne, Wyoming 82001

December 28, 1989

Ronald G. Starkey, State Supervisor
U.S. Fish and Wildlife Service
2617 E Lincolnway, Suite A
Cheyenne, Wyoming 82001

Attn: Mr. Arthur W. Anderson

Dear Ron:

Enclosed for your review are two copies of the project proposal Art Anderson requested from Charles Qualls of our office. If you believe that additional work should be done, please comment and return to us.

The transport of sediment, particularly bedload material, is an extremely complicated process. The U.S. Geological Survey, Corp of Engineers, Bureau of Reclamation, and several University are presently doing basic research and are building sediment-transport models which will answer the type of questions that you pose, what happens in the reach between two specified points such as "A" and "B"? However, only sediment transport models which answer a specified problem are available at this time, not models which will address the many aspects of the Snake River sediment transport problem.

The alternative to modeling the sediment transport is the collection of both streamflow and sediment data for the subreaches outlined in the proposal. In our proposed study, we plan to use as many existing streamflow-gaging station records as possible and would add only the stations that are necessary. Intensive bedload sampling will be required to obtain sufficient information to determine the deposition and erosion relations in this reach of the Snake River. These data would be extremely valuable for the testing of sedimentation models such as the Bureau of Reclamation's GSTARS model which is a streamtube model for alluvial simulation. This model can simulate both a fixed or movable bed but has not been applied to a braided river.

We would use a streamflow routing model to define the water-surface profile through the reach. We would be able to compute hydraulic conditions at each cross-section used in the study. The advantage of the model we propose to use (called the Branch-network Model) is that it can compute water-surface profiles for distributary channels. At present, the HEC-2 model being used cannot correctly handle the distributary channels; therefore, water surface elevations from right to left banks are averaged, when in reality the difference in elevations between the right and left banks can be as much as 3 feet. Neither our model nor the HEC-2 model can handle the movable bed problem at this time.

Appendix 9. (continued).

Preliminary project proposal
Prepared by the U.S. Geological Survey, WRD
Wyoming District
Cheyenne, Wyoming

Characterization of Hydrologic Conditions of the Snake River Between Moose and the Mouth of Flat Creek near Jackson, Wyoming.

PROBLEM:

Restraining the lateral movement of the channel in the 25 mile reach of Snake River between Moose and the mouth of Flat Creek near Jackson, Wyoming, has resulted in an imbalance between the energy required to transport sediment and the volume of sediment available for transport. This has resulted in changes in the wildlife and fishery habitat along the river. There is a need to define the extent of change throughout the reach so that managers of the resources can better determine changes that might occur in the future.

OBJECTIVE:

The objective of this project will be to define selected channel and hydraulic characteristics of the Snake River in the reach described above. The study will include determining surface-water profiles of the theoretical 50, 100, and 500 year floods, and size and quantity of sediments transported into and out of the reach, April through September of each year, as well as stream discharge.

BENEFITS:

Streamflow and sediment data collected for this study will provide information on sediment transport for the design of a stable river channel. In addition, the information can be used to improve data dependent sedimentation models such as IALLUVIAL or GSTAR (Fan, 1988).

APPROACH:

Historical stream flow data for the Snake River in the defined reach will be acquired and analyzed. The operating rules of the Jackson Lake dam will be aoquired to determine releases.

The project will account for nearly all surface flow and transported sediments into and out of the reach. To accomplish this task, streamflow-gaging stations will be established on the Snake River near Moose and on Fish Creek near its confluence with the Snake River. The streamflow-gaging station (13016100) Snake River near Wilson also will be re-established. Streamflow gages are presently in operation on the Gros Ventre near Zenith, Flat Creek, and the Snake River below Flat Creek near Jackson.

Appendix 9. (continued).

Continuous streamflow data, frequent samples of suspended sediment, and bedload material will be collected at each of the streamflow-gaging stations. The movement of bedload material will be sampled using a Helley-Smith sampler (Emmett, 1980). Sampling procedures will be followed to define both the spatial and temporal distribution of bedload. Sampling frequency will be designed to increase as streamflow increases. Data will need to be collected for a minimum of three years at the six stations.

Movement of bed material, bedload, is difficult to quantify; that is, the volume of material passing a point in the river can be determined, but the distance the material moves in a given time period is unknown. To overcome this unknown variable, a new procedure of implanting miniature radio transmitters in rocks for the purpose of tracking bed material movement will be used in this study (Emmett, 1989). Data from this part of the study will provide knowledge on the transit time of bedload material through the study reach.

A one-dimensional numerical model which simulates unsteady flow in a network of interconnected channels will be used to route streamflow through the system (Schaffranek and others, 1981). The model will be useful for computing the timing of large flows, flow velocities, and distributions of flows at several cross-sections between the streamflow-gaging stations.

A mass balance analysis of the sediment entering and leaving the system will be accomplished. The analysis will be made for sediment quantity by particle size distribution. From this analysis, reaches of the channel that are aggrading and degrading can better be determined.

All historical aerial photography of the system will be compiled to develop digital Geographical Information System (GIS) layers from which to characterize changes that have occurred, such as channel movement and vegetation changes. Channel changes so identified will be correlated to historical streamflow and a flood frequency analysis will be accomplished. All wetlands will be digitized as well for the reach for each specified time period so the GIS can be used to look at changes given changes in hydraulic controls.

COSTS: (Note: All cost are estimated at this time. Detailed cost analysis will be done prior to finalization of project.)

ESTIMATED CONSTRUCTION COSTS (pending reconnaissance):

Gaging stations @ $13,000 X 3 stations	$ 39,000
Cableways @ 15,000 X 3 stations	45,000
Sediment samplers (2 per sta.) $9,000 X 6 stations	54,000
Equipment	50,000
	188,000

SEASONAL OPERATING COSTS (April-September operation):

Streamflow gaging stations $5,000 X 3 stations	15,000
Bedload & suspended sediment sampling $15,000 X 6 sta.	90,000
	105,000 (1st year)

Appendix 9. (continued).

DISTRIBUTED COSTS:	Year 1	Year 2	Year 3	Year 4	Year 5
Construction	138,000				
Operation	105,000	111,000	117,000		
Radio Equip & Freq Anal	50,000	50,000			
Photointerp & Digit'z'n		50,000			
GIS Design & Install.		25,000			
Surveying		71,000	21,000		
GIS Database Maint.		8,000	8,000	8,000	8,000
Mapping*					
Flood Routing				85,000	
Report				40,000	40,000
	-------	-------	-------	-------	-------
Annual Totals	293,000	315,000	145,000	133,000	48,000

* Budget does not include engineering scale mapping, availability and/or cost of which was indeterminate as of this writing.

<u>REFERENCES</u>:

EMMETT, W.W., 1980, A Field Calibration of the Sediment-Trapping Characteristics of the Helley-Smith Bedload Sampler. U.S.G.S. Professional Paper 1139, U.S. Geological Survey, Denver, Colorado, 44 p.

EMMETT, W.W., and others, 1989, Gravel Transport in a Gravel-Bed River, Alaska. In Eos, Reference H11A-04, Vol. 70, No.15, April 11, 1989, p.320.

FAN, S., 1988, ed., Twelve Selected Computer Stream Sedimentation Models Developed in the United States. Federal Energy Regulatory Commission, December 31, 1988, 552 p.

SCHAFFRANEK, R.W., and others, 1981, A Model for Simulation of Flow in Singular and Interconnected Channels. U.S.G.S Techniques of Water-Resources Investigations, Book 7, Chapter C3, U.S. Geological Survey, Reston, Virginia, 110 p.

Appendix 9. (continued).

A Geographical Information System (GIS) data base of channel changes of the last 20 years would provide information on wetlands and changes in the river environment due to modification to the Snake River channel.

The cost of the proposed project is significant, but once the data is collected and analyzed the resulting information will be valuable for design, knowledge, and protection of the environment. If you have additional questions please contact myself or Charles Qualls at FTS 328-2153.

for/James E. Kircher
District Chief