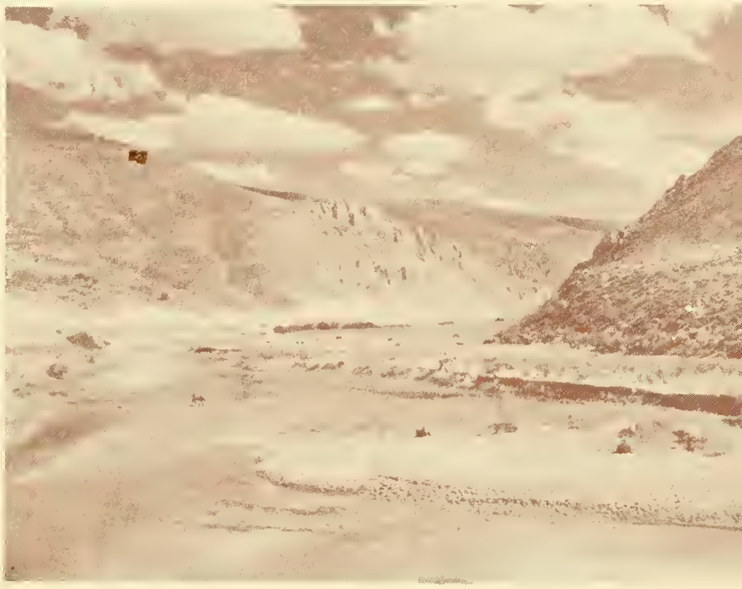
WATER and RELATED LAND RESOURCES
HUMBOLDT RIVER BASIN
NEVADA



REPORT NUMBER TWELVE

BASINWIDE REPORT

November 1966

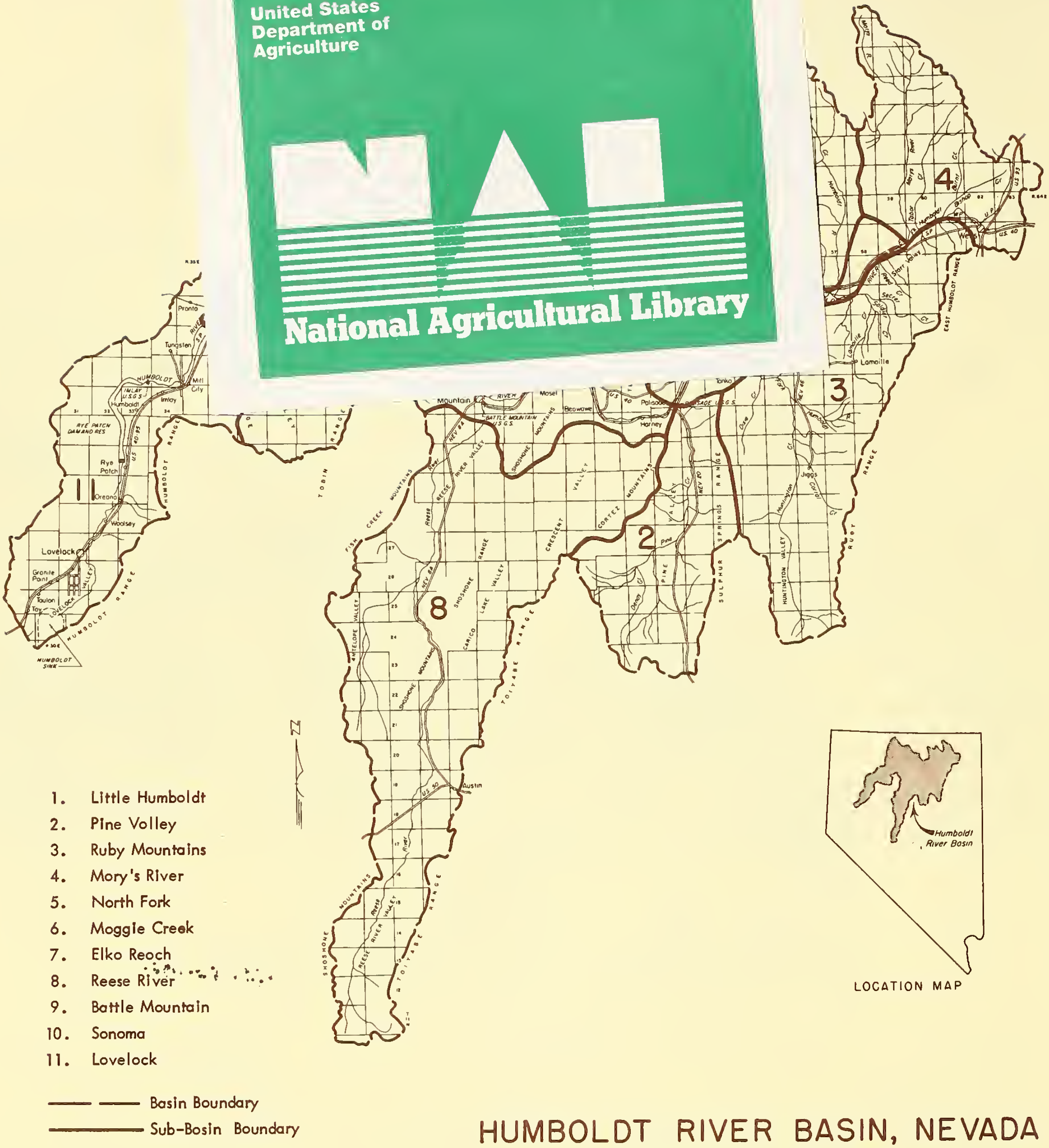
Based on a Cooperative Survey

by

THE NEVADA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
and THE UNITED STATES DEPARTMENT OF AGRICULTURE

Prepared by

Economic Research Service - Forest Service - Soil Conservation Service
Max C. Fleischmann College of Agriculture, University of Nevada, Reno



HUMBOLDT RIVER BASIN, NEVADA

SHOWING SUB-BASINS

Cover Photographs --- *Three photographs depict the Humboldt River at three locations which typify its 300-odd mile course.*

Upper Photograph: Rye Patch Dam and Reservoir, in the lower Humboldt Basin, is the basin's largest and most important water storage facility. SCS PHOTO 6-151-8

Lower Left Photograph: The clear, cold headwaters of Lamoille Creek, with the snowfield along the main divide of the Ruby Mountains source area glistening in the background. SCS PHOTO 6-938-2

Lower Right Photograph: The oxbow loops of the Humboldt main stem in Carlin Canyon. NEVADA STATE HIGHWAY DEPT. PHOTO

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1966 M-4480-1

REGISTER

REPORT NUMBER TWELVE

BASIN-WIDE REPORT

November 1966

Will you please detach and fill out this form; mail it to us, so that we may send you any additions, changes, or corrections.

U.S.D.A. River Basin Field Party
P.O. Box 228
Carson City, Nevada 89701

Name ______________________________

Address ______________________________

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Basinwide Report
on
HUMBOLDT RIVER BASIN NEVADA

Based on a Cooperative Survey
by
THE NEVADA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
and THE UNITED STATES DEPARTMENT OF AGRICULTURE

Report Prepared by
USDA Humboldt River Basin Field Party
Elko, Nevada
and
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Other Reports of this Series on the Humboldt River Basin
Prepared by the Same Authors:

Report Number	Title	Publication Date
1	Little Humboldt Sub-Basin	March 1962
2	Pine Valley Sub-Basin	June 1962
3	Ruby Mountains Sub-Basin	May 1963
4	Mary's River Sub-Basin	June 1963
5	North Fork Sub-Basin	August 1963
6	Maggie Creek Sub-Basin	October 1963
7	Elko Reach	April 1964
8	Reese River Sub-Basin	June 1964
9	Battle Mountain Sub-Basin	October 1964
10	Sonoma Sub-Basin	May 1965
11	Lovelock Sub-Basin	November 1965
Special Report	Chronology of Flood Years and High Water Years	June 1962

ACKNOWLEDGEMENTS

Many individuals, groups, and agencies - Federal, State and private - furnished pertinent pictorial, factual, textual, or statistical material in the preparation of this basinwide report for the Humboldt River Basin. The writing and publication of the sub-basin report series was also greatly aided and expedited through the contributions of time, effort, information, and photographs furnished from many sources.

It seems desirable, therefore, that all such sources of information or material used in the USDA-Nevada Humboldt River Basin Reports receive acknowledgement in this, the twelfth and final report of the series. Through this medium the Field Party and the Field Advisory Committee are taking a last opportunity to extend their thanks and appreciation to all who helped. In the event, however, that some individual or group has been overlooked in the following list, please be assured that such omissions were truly inadvertant and unintentional.

U.S. Department of Agriculture
- Humboldt and Toiyabe National Forests
- Agricultural Stabilization and Conservation Service
- Agricultural Research Service

U.S. Department of the Interior
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- Bureau of Indian Affairs
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County

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Quasi - Public Organizations

Pershing County Water Conservation District; Carlin Gold Mining Company; Humboldt Engineering Associates; Austin, Big Meadows, Humboldt River, Jiggs, Lamoille, Northeast Elko, Owyhee, Paradise Valley, and Sonoma Soil Conservation Districts.

Newspapers

Elko Free Press; Elko Independent; Wells Progress; Reese River Reveille; Lovelock Review-Miner.

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FOREWORD

This report is a basinwide summary of information from a cooperative survey of the Humboldt River Basin by the Nevada State Department of Conservation and Natural Resources and the U.S. Department of Agriculture. The summary is based on 11 sub-basin reports which were prepared concerning water and related land resources for the people of Nevada, and particularly for the people of the Humboldt River Basin.

The cooperative survey was for the primary purpose of determining where improvements in the use of water and related land resources which have social and economic aspects might be made with the assistance of projects and programs of the U.S. Department of Agriculture. A major part of the survey is focused on situations where improvement might be brought about by means of Federal-State-local cooperative projects developed under the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, as amended).

In each of the 11 sub-basin reports, I expressed recognition of the excellent work of the U.S. Department of Agriculture and the Nevada Department of Conservation and Natural Resources. I wish to emphasize such recognition in this Summary Report. The objectives and purposes of the survey and the preparation of reports have been accomplished. This phase of the cooperative work is now completed.

This is only a beginning. The second phase will be that of further development of the water and land resources of the basin. This phase will require able and diligent translation and conversion of the technical and other findings contained in the reports into the actual establishment of works of improvement. With respect to the Humboldt River Basin, we now know what needs doing - what the opportunities are. Furthermore, we have the skills to do them.

Our job now is to embark on courses of action to take advantage of opportunities, and to provide the improvements. It occurs to me this task is Administrative and Managerial, and has its deepest roots in local-State-Federal relations and cooperation. The ultimate responsibility for initiating action rests on the local people, their institutions and organizations, because interest, desire and leadership on their part are vital to the success of soil and water conservation programs and projects. Of no less importance is the assistance of State and Federal agencies and organizations that have primary responsibility for such programs and projects.

Obviously, local and Federal interests must be consulted in this work. Therefore, I am asking the Nevada Resource Action Council, which has been organized for this very purpose, to cooperate and assist the Department of Conservation and Natural Resources in the development of this program. The U.S. Department of Agriculture agencies who had a part in the preparation of the survey reports have informed me of their desire to assist in this implementation phase. I am confident that the cooperative efforts of these agencies will result in the best development of the natural resources of the Humboldt River Basin.

Grant Sawyer

Governor of Nevada

HUMBOLDT RIVER BASIN SURVEY

BASIN-WIDE REPORT

CONTENTS

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INTRODUCTION

Historically and currently, the use of water in the Humboldt Basin is for agricultural purposes, and the outlook at this time is for agriculture and recreation to share dominance as the principal water-using industries. Development in most of the basin has reached a stage where further expansion and stabilization of the agricultural industry is dependent upon more efficient utilization of water, and the development of salvaged or new water supplies.

The State of Nevada recognized the need for a systematic survey of water and related land resource conditions and problems in the Humboldt River Basin. It was felt that such a survey would develop information for the coordination of programs and projects in the basin. In addition, the State needed information from agencies of the U.S. Department of Agriculture which would fill the gap existing between farm-by-farm conservation operations and the programs and project information available, or to be made available, by the Corps of Engineers and the Bureau of Reclamation. The State's participation in this survey was provided under authorization by the 1959 session of the Nevada Legislature.

The Secretary of Agriculture is authorized under the provisions of Section 6 of the Watershed Protection and Flood Prevention Act to cooperate with other Federal and with State and local agencies in making investigations and surveys of the watersheds of rivers and other waterways as a basis for the development of coordinated programs. In the Humboldt Basin, the Department needed information to help in coordinating the development of water and related land resources. These improvements would be centered in sub-watershed areas of 250,000 acres or less, in connection with providing assistance to local organizations in the development of those resources under the provisions of the Watershed Protection and Flood Prevention Act (Public Law 566). The Department also desired to point out opportunities for development of water resources on the national forests, as a part of the multiple use development of their natural resources.

Results of this Nevada-USDA Cooperative Survey are published in reports written on 11 segments of the Humboldt Basin called sub-basins (see fly page of this report). This report, Basinwide Report, number twelve in the series, contains information as to what might be accomplished by feasible Public Law 566 projects and other Department of Agriculture land and water activities in solving the Basin's resource management problems.

General direction for the U.S. Department of Agriculture in the conduct of the studies and preparation of the report series was provided by a USDA Field Advisory Committee composed of representatives of the Soil Conservation Service, Forest Service, and Economic Research Service. The USDA River Basin Representative served as advisor and consultant to the committee.

General direction for the State of Nevada was provided by the Director of the State Department of Conservation and Natural Resources.

A Field Party, composed of representatives of the Soil Conservation Service, Forest Service, and Economic Research Service, completed the field work and prepared the reports.

A section of the Basinwide report devoted to the economics of range and cropland developments was prepared by a staff member of the Max C. Fleishmann College of Agriculture, University of Nevada, from basic data furnished by the Field Party.

Grateful acknowledgement is made to all individuals and to the personnel of other State and Federal agencies who gave their counsel and technical assistance in the preparation of the reports.

SYNOPSIS OF OPPORTUNITIES FOR DEVELOPMENT, HUMBOLDT RIVER BASIN

Use of Water

About 93 percent of the estimated 9,285,000 acre-feet of moisture that falls in the Humboldt River Basin during a 50 percent chance year is used by the grasses, shrubs, and trees which grow on the watershed lands, or is evaporated from the land surface. The remaining seven percent is used on irrigated land in the tributary valley bottomlands, irrigated alluvial fans, and along the flood-plain of the Humboldt River.

Border, furrow, and sprinkler methods of irrigation, where applicable, offer a better opportunity for higher water use efficiency than the semi-controlled wild flooding so widely used. Consolidation of existing canal systems, lining of ditches, and the removal of tight dams would also increase water use efficiency.

Nonbeneficial phreatophytes use an estimated 196,000 acre-feet of water annually, which is more than one-fourth the total water use in the basin, or about 27 percent of the annual water yield. Much of this nonbeneficial use could be eliminated by the control or replacement of the nonbeneficial phreatophyte species. The control of cottonwood, willow, and tamarisk, for instance, would render about 20,000 acre-feet of water available for beneficial use.

Flood Control

The Field Party found 20 small watersheds which might be improved under the provisions of the Watershed Protection and Flood Prevention Act, Public Law 566, within the Humboldt Basin, with 12 or more possible dam sites. Most of these projects would include some provisions for flood control.

Range and Watershed Improvement

As of the summer of 1964, there were 231,000 acres of range seeded to perennial grasses in the basin. It is estimated an additional 1,019,000 acres can be successfully seeded. Present average annual forage production in the basin can be increased an estimated 2.4 times by brush overstory removal and seeding on all suitable sites, and by adhering to proper range management practices, such as proper stocking, deferred-rotation grazing, and uniform livestock distribution.

If the full range betterment program recommended for the Humboldt Basin were followed, it is estimated that the $3,046,615 present annual net income could be increased to a potential net income of $13,455,974.

Recreation Use

The Forest Service, in planning for recreation use to meet the public's needs to the year 2000, has inventoried 81 new camp, picnic and organization sites, having an approximate total of 1,945 family units.

The Bureau of Land Management has to date identified approximately 54 sites having recreation possibilities in the basin, for development by the year 1980.

Municipalities and county governments are also involved in the development of public recreation areas. A number of opportunities exist in the Humboldt Basin whereby private landowners can provide a large part of the recreation need, with income to the owners and satisfaction to the users.

There are many opportunities for developing additional water-based recreation in the basin, as evidenced by the 12 or more possible dam sites inventoried by the Field Party and the three upstream-storage dam sites proposed by the Corps of Engineers.

HISTORY OF SETTLEMENT

Early Exploration

The history of the white man's settlement of the Humboldt Basin, and his development and exploitation of its resources, may be chronologically divided into four general periods: fur trapping, emigration and transportation development, mining, and agriculture. These periods had no finite timewise demarcations for the most part, and one period quite frequently overlapped or shaded into the succeeding period or periods.

The first white men to set foot in the Humboldt country were the fur trappers of the Hudson's Bay Company's Fifth Snake Country Expedition, led by Peter Skene Ogden. On November 9, 1828, this group crossed from the Quinn River drainage to the Little Humboldt River in the Humboldt Basin by way of Paradise Hill Pass, and proceeded down the Little Humboldt to its junction with the Humboldt main stem. Ogden named the Humboldt "Unknown River" at that time, because he knew not from whence it came or where it went.

Later in 1828, after the death of Joseph Paul, one of Ogden's trappers, along its banks - the first white man to die and be buried on the Humboldt - the river was called Paul's River. In the summer of 1829, after having wintered in Utah's Wasatch Mountains, Ogden returned to the Humboldt Basin, and eventually reached the Lovelock Valley sloughs and the Humboldt lakes. At that time he proposed the name Swampy River for the Humboldt. During the remainder of the fur trapping period, however, and well into the California emigration period, the Humboldt was generally known as Ogden's River, or Mary's River, after the Indian wife of one of Ogden's trappers. The 1833-1834 Bonneville-Walker fur party named it Barren River, because of the absence of trees along its banks.

Its present name did not become associated with the river until the publication of John C. Fremont's Geographical Memoir and Map in 1848. On this map, Fremont appended the name Humboldt to the river, from the Prussian explorer-naturalist, Baron Alexander von Humboldt. The map, with its wide distribution, was the principal medium in the eventual acceptance of this completely unrelated and unassociated name for the stream.

Ogden's 1828-1829 Humboldt Basin travels are of great importance, not only because he and his men were the first whites to see the Humboldt, and trace it "from its source to its sink", as Dr. Gloria Cline phrases it, but because Ogden produced the first true map of the Humboldt Basin. Ogden was also the first to set down written descriptions of northern and central Nevada, and along with his successor, John Work, to disprove the existence of the mythical Buenaventura River.

Following Ogden's trapping forays and explorations along the Humboldt and many of its principal tributaries, John Work, succeeding to the command of the Snake Country fur brigade, traversed most of the middle and upper reaches of the Humboldt River in the Snake Country Expedition of 1831. The last important fur-taking group, the well-led but ill-advised and untimely Bonneville-Walker party of American trappers, went west along the Humboldt to California in 1833 and returned eastward by the same route the following year.

Emigration and Transportation Development

The period of emigration and transportation development in the Humboldt Basin began with the passage of the mounted Bidwell-Bartleson Party down the Humboldt in 1841. However, the definite establishment of the California Emigrant Trail as such cannot be said to have occurred until 1843. At that time Joseph Walker, the famous mountain man and guide, brought the Chiles Party, the first wagon train, down the Humboldt main stem, over his return route from California to southern Idaho with the Bonneville fur party in 1834.

The long strings of covered wagons along the California Trail from Humboldt Wells to Big Meadows continued in full panoply until the opening of through railroad travel following the joining of the Central Pacific and the Union Pacific Railroads at Promontory, Utah, in May 1869 (see photograph 1). After that date, westbound overland emigration by wagon train dropped off markedly with the institution of crowded emigrant railroad travel on the Central Pacific. However, wagon train emigration continued on a fairly extensive scale until the late 1870's.

Almost coincident with the peak of covered wagon travel, from 1851 until the late 1870's, many freighting and staging transportation ventures developed throughout the basin. This was the era of Woodward & Chorpenning's Jackass Mail, the brief, hectic saga of the Pony Express, the heavy Concord coaches of Butterfield's Overland Stage and Telegraph Company, and the "mud-wagons" of Woodruff & Ennor, William (Hill) Beachey's Railroad Stage Lines, and the Northwestern Stage Lines. In addition, innumerable feeder stage lines and long strings of cumbersome freight wagons plied between the towns along the Humboldt main stem and their satellite mining communities.

The construction of the Central Pacific Railroad up the Humboldt Valley from Lovelock (then called Lovelock's Station, or simply Lovelock's) to Humboldt Wells (Wells) during the period from July 1868 to February 1869 marked the full flowering of the transportation period. In 1899 the Central Pacific became an integral part of the vast Southern Pacific rail network. At the present time, the Southern Pacific remains one of the most important transportation arteries in the basin.

The Western Pacific, the second transcontinental rail link traversing the Humboldt Basin, was constructed along the Humboldt River from Wells to Winnemucca during the period 1907-1908. It now shares a paired-track arrangement with the Southern Pacific between those points (see photograph 2).

During the period 1873 to 1878, many independently-owned feeder rail lines, all of them narrow (three feet) gage, were constructed. They bloomed and prospered awhile, and now remain only as fond, fragrant memories to old residents and railroad historians. The last two, the Eureka-Nevada and the Nevada Central, suspended operations in 1938.

One standard gage branch, belonging to the Southern Pacific, was completed from Tulasco siding on the Central Pacific (Southern Pacific) main line in the upper basin to the agricultural boom town of Metropolis in 1911. The branch was removed in 1925, after the brief Metropolis agricultural bonanza had sputtered and died.

Photograph 1. - Ruts of the California Emigrant Trail west of Emigrant Pass, in the Battle Mountain Sub-Basin, with historic Gravelly Ford about three miles distant in the right background. ADRIAN ATWATER, NEVADA STATE HIGHWAY DEPT. PHOTO

Photograph 2. - A Southern Pacific freight rolling eastward over Western Pacific trackage at Dunphy in the Battle Mountain Sub-Basin. The Southern Pacific main serves as the westbound track, the Western Pacific the eastbound, in the paired-track arrangement of the two lines between Wells and Winnemucca. FIELD PARTY PHOTO

The automobile highway era began in 1914, with the designation of the old Butterfield Overland Stage road and the Pony Express trail across Central Nevada as the Lincoln Highway. In the Humboldt Basin, this pioneer transcontinental highway, following the Overland Road along the Cental or Simpson route, crossed Reese River Valley from Austin to Mt. Airy.

In 1917, with the establishment of the Nevada Department of Highways, the old California Emigrant Trail along the Humboldt from Wells to Lovelock began to be pieced together with portions of Central Pacific grade abandoned in the 1901-1903 Southern Pacific line changes. This amalgamation was designated as State Route 1; the Lincoln Highway became State Route 2. By late 1924 State Route 1, by then renamed the Victory Highway, although far from being a finished, uniform thoroughfare, was open to auto travel across all of Nevada, and over the wall of California's Sierra Nevada to Sacramento and Oakland. By 1926, under its new U.S. 40 designation, it had been completed to the standard of that time, and located approximately on its present alignment.

Both transcontinental highways retained their names - Victory Highway and Lincoln Highway, respectively - until 1925, when they became U.S. Highways 40 and 50 in the Federal Highway system. In the 1950's, newly linked-up U.S. Highway 6 began sharing U.S. 50's route through Nevada.

At the present time, U.S. Highway 40 is being rapidly reconstructed and fourlaned into the Interstate 80 freeway system through the Humboldt Basin. Plans call for this work to be completed by 1972. (See photograph 3.)

In addition to the Federal highways, a network of State routes, paved or gravelled, has been developed, linking Humboldt Basin localities by highway ties with points north, south, east and west, both within and outside the basin.

Mining

The discovery of silver ore in the northern reaches of the Humboldt and East Ranges in the period 1860-1862, with the ensuing "Rush to Humboldt", started the first large-scale permanent settlement of the Humboldt Basin by whites. Humboldt City and Dun Glen in the Humboldt Basin, together with Unionville and Star City just south of the basin's boundaries, became the first white settlements to spring up in Nevada north and east of the Comstock cities (see photograph 4). The tide of emigration, which since the mid-1840's had streamed westward along the Humboldt unknowing of the mineral riches and unconcerned about the rich, lush livestock ranges it was bypassing, was suddenly reversed.

The Humboldt silver strikes were followed in short order by those at Austin, on Reese River, in 1862 (see photograph 5). Following the Austin strikes, in the 1860's and early 1870's many famous Nevada silver and gold camps sprang to life within or immediately adjacent to the Humboldt Basin, such as Tuscarora, Cortez, Tenabo, Mineral Hill, Eureka, Hamilton, Treasure Hill, etc.

Prospecting and mining activity in the Humboldt Basin tapered off in the 1880's and came to a virtual standstill following the repeal of the Sherman Silver Purchase Act in 1893 and the resultant demonetization of silver. However, there was a general upsurge in mining all over Nevada in the first decade of the Twentieth Century, following the fabulous silver and gold strikes at Tonapah and Goldfield in the early 1900's. In the Humboldt Basin, this resulted in the emergence of such mining camps as Midas, Rochester, National, and Buckhorn, as well as a general revival in many of the old camps (see photograph 6).

Photograph 3. - The Interstate 80 freeway loops and twists its way eastward across Golconda Summit, with the snow-caps of the Sonoma Range in the western background. The abandoned U.S. Highway 40 alignment is seen at the right of the photograph. Sonoma Sub-Basin. ADRIAN ATWATER PHOTO

Photograph 4. - Decaying remnants of old Humboldt City, the first of the Humboldt silver strike cities, in the Lovelock Sub-Basin. FIELD PARTY PHOTO --- 6-867-12

Photograph 5. - Upper Austin, in the Reese River Sub-Basin, and the Lander Hill mines as they appeared in the 1890's. The mill and concentrator of the Austin Mining Company, originally the Manhattan Silver Mining Company, appear at the right of the photograph.
NEVADA HISTORICAL SOCIETY PHOTO

Photograph 6. - The main street of Midas, Battle Mountain Sub-Basin, as it appears today.
FIELD PARTY PHOTO --- 6-784-9

Tungsten mining became important during the period of World War I, continuing during the depression years, World War II, and the Korean War. However, with the withdrawal of the U.S. Government tungsten purchase program in 1957, all tungsten mining came to a halt. At the present time, the only large-scale mining operations in the basin are the Carlin Gold Mining Company, a subsidiary of Newmont Exploration, Ltd. (gold) in the Maggie Creek area, the gold ores section of the Getchell Mines near Golconda, and the open pit iron mine of Nevada Barth, in Palisade Canyon (see photograph 7). In addition to these, the Duval Corporation is developing an open-pit copper mining operation in the Galena Range southwest of Battle Mountain.

All principal towns along the Humboldt main stem developed during the early mining period, to service the booming mining camps, and to function as terminal points for stage and freight lines radiating to the camps from the Central Pacific Railroad. Lovelock was established to serve Arabia and Trinity in August 1868; Mill City later that same month was established as a point of departure for the Humboldt Strike silver towns. Winnemucca, already located (1866) at the site of old French Bridge when the Central Pacific reached there in September 1868, functioned at first primarily as a terminus for staging and freighting operations to the silver and gold camps of southwest Idaho (see photograph 8). However, by the early 1870's it had become the entrepot for the Paradise Valley mines, and a rival of Battle Mountain, Carlin, and Elko for the flourishing trade with the northern Elko County mining camps - Cornucopia, Columbia, and Tuscarora. It also competed via Grass Valley with Battle Mountain for Austin trade, prior to the completion of the Nevada Central Railroad in 1879.

Battle Mountain, replacing Argenta in December 1869-January 1870 as the take-off point for the Austin and other upper and lower Reese River mines, developed stage and freight lines reaching northward to the northern Elko County camps also.

Carlin, first laid out in early December 1868 as the eastern terminus of the railroad's Humboldt Division, soon had freighting and staging operations stretching to the north Elko County camps, as well as to Bullion, Mineral Hill, and Eureka to the southward.

Elko, whose townsite was laid out December 29, 1868 by Central Pacific engineers immediately after the railroad reached there, was originally established as a point of departure for passengers and freight heading south for the White Pine mining district (Hamilton, Treasure Hill), as well as to Cope, Columbia, Cornucopia, and a short while later, Tuscarora. By early 1870, Elko had snatched away from Winnemucca its envied status as the principal Central Pacific terminus for travelers and freight destined for the southwest Idaho mines.

However, Elko was not to enjoy this valued Idaho terminal status for long. After operating during the winter of 1870, it was soon found that the snow-plagued Elko & Idaho and Idaho Central toll roads between Elko, Silver City, and Boise City were too difficult to keep open during the winter months. By 1873, much of this trade with Idaho had reverted to Winnemucca, or gone farther east along the railroad to Toano and Kelton.

The town of Wells - first called Humboldt Wells - near the site of the springs and meadows of California Emigrant Trail fame at the Humboldt headwaters, was first established by the Central Pacific early in 1869 as a locomotive water stop (see photograph 9). Soon afterward, Wells became a helper engine terminal and railroad division point. It assumed equal importance as a freighting and staging hub for the Egan Canyon, Cherry Creek and White Pine mines south of the Humboldt, and the copper mines at Contact to the northward, as well as a ranching supply center.

Photograph 7. - Aerial view, ore-reduction mill of the Carlin Gold Mining Company, a subsidiary of Newmont Exploration, Limited. The mill is located on the Maggie Creek-Boulder Creek divide, about 10 miles north of Carlin, on the divide between Maggie Creek and Battle Mountain Sub-Basins. BECHTEL CORP. PHOTO

Photograph 8. - Bridge Street, Winnemucca, from the old Winnemucca Hotel, 1902, looking southward to the Sonoma Range. Sonoma Sub-Basin. NEVADA HISTORICAL SOCIETY PHOTO

Photograph 9. - One of the springs used by the emigrants in the Humboldt Wells meadows, immediately northwest of present Wells, in the Mary's River Sub-Basin. ADRIAN ATWATER PHOTO

Photograph 10. - Loaded freight wagons and teams enroute to Tuscarora from Elko, circa 1875-1880. ANTOINE PRIMEAUX PHOTO

Development of Agriculture and Related Enterprises

As the flow of settlement spread up the Humboldt Valley from west to east during the period from 1860 to 1870, following the construction of the Central Pacific Railroad and the progress of mining development in that direction, the establishment of ranching and the agricultural industry began. At first, these ranches in the lush valleys of the Humboldt and its tributaries were merely adjuncts to the freighting and staging lines, raising the hay and grain needed to feed the enormous numbers of draft and pack animals used for the pack strings and to pull the freight wagons and stages (see photograph 10).

Each section of the basin soon began to specialize in that form of agriculture best suited to its particular needs. Lovelock Valley quickly developed as an area of relatively small ranches or farms raising hay and small grains. To supplement the natural irrigation afforded by the Humboldt sloughs, the first irrigation distribution systems in the Humboldt Basin, primitive forerunners of the present Lovelock Valley canal network, began to be laid out as early as 1866.

Paradise Valley, from the time of original settlement in 1863 until 1878, when silver was discovered in paying quantities there, was even more important than the Lovelock area as a granary during this early period, not only for the Humboldt and Reese River mines, but also for the northern Elko and southwest Idaho mining camps (see photograph 11). In 1868, to process the increasingly heavy crops of wheat and barley being grown in the valley, Nevada's pioneer flour mill was established by C. A. Adams on Martin Creek, near Scottville (Paradise City).

Photograph 11. - Threshing grain with a steam tractor, western Nevada, in the 1890's. Although the picture was not made in Paradise Valley, it is typical of the threshing operations in the valley during the period 1878-1918. ROY MILLS PHOTO

Photograph 12. - Ranch headquarters, Stock Ranch, Paradise Valley (Little Humboldt Sub-Basin). Over the gateway hang the ox yoke, ox bell, and hame bells worn by William Stock's oxen when he came to the valley to settle in 1866. ADRIAN ATWATER PHOTO

Paradise Valley continued to be important as a granary area until well after the turn of the century; during this same period its fame as a fruit and produce area was widespread. The valley early began to supply garden truck, fruit, honey, and poultry to all the adjacent mining camps, although only small vestiges of its once extensive orchards remain today. This phase of the valley's agriculture was particularly important during the period 1878-1918. It was also during this period that the livestock industry here, originally a sideline, began swelling to large proportions. As with its small grains, Paradise Valley became one of the principal suppliers of meat to the mining camps, in the form of beef, pork, and mutton (see photograph 12).

The raising of livestock on a large scale in the Humboldt Basin, and indeed for the entire State, may be accurately dated from 1862. At that time L. R. "Old Broadhorns" Bradley, later to become Nevada's second Governor (1870-1878), established, with his son John Reuben and his partner James Rooker, a large cattle ranch in the green Reese River meadows southwest of Austin, stocking it with 500 head of Texas longhorn cattle. From this beginning, the range livestock industry quickly spread northward to Winnemucca, and eastward from there over the middle and upper reaches of the Humboldt Basin. Some of the historic Nevada livestock operations developed during the 1862-1890 era of immense cattle and sheep ranch holdings, carrying such famous irons as the 25, the Horseshoe, the Diamond A, the Winecup, the Shoesole, the T S, and many others. Livestock were ranged yearlong on the great expanses of open sagebrush-grass range, and along the Humboldt River Bottomlands, with little or no supplemental feeding during the winter months.

The disastrous "White Winter" of 1889-1890 was instrumental in bringing about the eventual breakup of many of these great livestock empires, a large number of which were larger than the areas of several small eastern States combined. This winter, with its enormous livestock losses, also put an effective stop to the loosing of cattle, sheep, and horses on the open range during the winter months without the use of hay or other supplemental feeds. From this time onward, the growing of irrigated native and alfalfa hay for winter livestock feeding became a major agricultural activity throughout the Humboldt Basin.

Accompanying this drastic change in livestock feeding and care from the old casual, carefree days before the White Winter, purebred cattle, principally the Hereford breed, began to replace the Texas Longhorn. John Sparks, of the immense cattle outfit of Sparks & Harrell, with holdings from Wells in Nevada to Idaho's Snake River, and Governor of Nevada, 1902-1908, is credited with being the principal early developer of the Hereford breed in Nevada, starting in 1894. However, Joseph Scott, of Scott & Hank, owners of the historic 71 Ranch near Deeth, was the first to introduce Herefords into the State, in 1879.

In Lovelock Valley, now the Humboldt Basin's principal area of diversified agriculture, the period of organized irrigation from large permanent structures in the Humboldt River may accurately be said to date from 1876. At that time, Joseph Marzen, Lovelock Valley livestock operator, and the first man to successfully grow alfalfa in the Humboldt Basin, and Peter Marker constructed the Marzen and Marker diversions in the Humboldt above Lovelock, to irrigate their lands in the middle and lower portions of the Lovelock Valley. In the succeeding years, other structures and canal systems were installed as the valley's agriculture became more intensified.

In their continuing search for more and more irrigation water, the Lovelock Valley ranchers began work in 1910 on the diversion canal and structures for the Pitt-Taylor

Reservoirs near Mill City. The two reservoirs began storing water in 1913.

In 1926 the Lovelock Valley Irrigation District was formed, and in 1929 the district's name was changed to its present title, Pershing County Water Conservation District, preparatory to the construction of Rye Patch Dam and Reservoir by the U.S. Bureau of Reclamation in 1935. Rye Patch Dam, costing $1,370,000, including purchase of some Battle Mountain ranch lands and their appurtenant water rights, was completed in 1936, and immediately began filling its 192,000 acre-feet storage space. Irrigation water from the reservoir then began to be distributed in Lovelock Valley through six diversion structures.

Resource Conservation Activities

The first organized effort toward the conservation and management of the soil, vegetal, and water resources of the Humboldt Basin began with the creation in 1906 of the Ruby Mountains Forest Reserve, now the Ruby Division of the Humboldt National Forest. The first unit of the present Toiyabe National Forest in the basin came into being in 1907, with the creation of the Toiyabe Forest Reserve, now a portion of the Central Nevada Division of that national forest, in the Reese River Sub-Basin.

Following the passage of the Taylor Grazing Act in 1934, the first grazing districts in the basin were set up in 1935, under the Division of Grazing in the Department of the Interior. This Federal bureau later became the Grazing Service, and finally the present Bureau of Land Management.

The first of the present large number of soil conservation districts in the basin, the Starr Valley and Owyhee, were organized in 1946. At present portions of 11 soil conservation districts, organized under authority of State statutes, cover nearly the entire basin. The only portion of the basin not included within the boundary of a district is a small acreage in southern Pershing County.

The two Indian reservations, the Te-Moak in the Ruby Mountains Sub-Basin, and the Yomba in the Reese River Sub-Basin, were both established in 1939 through the purchase of several contiguous small ranches.

PREVIOUS STUDIES

Federal Government

The Bureau of Reclamation prepared a report in 1919 titled Humboldt River Investigation. A study of the Rye Patch Dam and Reservoir Site was started in 1934, which resulted in the construction of the Rye Patch Dam, 1935-1936. A report, Humboldt Project, Nevada, was prepared in 1952 presenting the drainage, irrigation, and flood control problems of the project, and proposals for their alleviation.

Studies were made and drainage and emergency flood-control improvements were constructed by the Corps of Engineers starting in 1945 to protect the lower Lovelock Valley. Reconnaissance studies were made for several flood-control projects in Paradise Valley on Martin Creek and on the Little Humboldt River, which resulted in a negative report being filed by the Corps in 1961. Another report was prepared by the Corps in 1950 on a preliminary examination of the Humboldt River and tributaries which proposed three upstream storage dams. Since the issuance of the 1950 report, feasibility studies have been made for these structures. In connection with these studies, in 1965 an operation plan for the Corps' Humbolt River Project was developed and published by the Humbolt Engineering Associates for the Nevada Department of Conservation and Natural Resources.

U.S. Geological Survey activities include: Topographic surveys on Martin Creek and the Little Humboldt River (1934), Upper Reese River (1935), Mary's River (1935-1936), and the South Fork of the Humboldt River (1936); surface water stream gage readings, ground water reconnaissance reports; ground water information reports; and water resource bulletins.

State Government

The State Engineer made a survey and an investigation of dam sites in the Humboldt Basin prior to 1919. Included in this study were the dam sites on Rock Creek and Lower Maggie Creek.

Between 1949 and 1952, the State Engineer made a hydrographic study of the waters of the Humboldt River and tributaries, in connection with the proposed upstream storage reservoirs and stream channel improvements. A report of this study was written by Edmund Muth, then Special Assistant State Engineer.

The University of Nevada has published numerous bulletins which concern water and related land resources. The Desert Research Institute at the University has conducted investigations and published reports on geology and hydrology in the Humboldt Basin. At the present time the institute is conducting a long-term weather modification research project near Elko.

An unpublished report to the Upper Humboldt River Water Storage Committee entitled Economic Feasibility of Upper-Stream Storage on the Humboldt River Watershed was written by John W. Couston, Consulting Agricultural Economist, Agricultural Economics Department, University of Nevada.

The State Department of Conservation and Natural Resources is cooperating with several Federal agencies in the Humboldt River Research Project at Winnemucca, and with the U.S. Geological Survey in its ground water studies.

Other

In the field of range management, the 1938-1941 Northeastern Nevada Cooperative Land Use Study prepared maps of range vegetal types and soils information, and developed data on pounds-per-acre yields of range forage species. This study was a joint Federal-State enterprise.

PHYSICAL CHARACTERISTICS

Geology

The Humboldt River Basin is situated in north-central Nevada, in the Great Basin section of the Basin and Range physiographic province. The basin comprises an area of about 17,000 square miles, or about 15 percent of the State.

Valleys in the basin range from less than 3,900 feet in elevation (Humboldt lakes) to 7,000 feet (upper Reese River Valley), with adjacent mountains rising 2,000 to 4,000 feet above the valley floors. The mountain ranges crest between 6,000 and 10,000 feet in elevation. The Toiyabe Range and the Ruby Mountains have the highest elevations in the basin, with peaks of 11,788 and 11,349 feet respectively (see photograph 13). The Humboldt River flows generally westward, transverse to the north or northeast - trending mountains and valleys.

Photograph 13. - The camera is pointed westerly across the headwaters of Reese River toward Arc (Toiyabe) Dome, at 11,788 feet the highest point in the Humboldt Basin. Reese River Sub-Basin. FIELD PARTY PHOTO

Lake Lahontan, a former lake in Pleistocene time, inundated the lower part of the river basin to an elevation of about 4,400 feet. This lake formed wave-cut scarps, built terraces, beaches, gravel bars and spits, and developed an extensive lake-bottom plain on lacustrine deposits. The lake plain has been modified by wind action, which scoured depressions and formed dunes. Other lakes besides Lake Lahontan formerly inundated portions of the river basin.

Physiographically, the Humboldt Basin can be divided basically into mountains, intermediate slopes or uplands, and valley floors or lowlands. Uplift, gentle warping and faulting have contributed to the present relief.

The mountains are composed principally of folded and faulted consolidated rocks. They include detrital, carbonate, igneous, and metamorphic rocks of Paleozoic and Mesozoic ages, and younger volcanic and intrusive rocks of Cenozoic age (see photograph 14). Volcanic ash is identifiable at various periods in deposits of Quaternary age. Several mountain ranges, such as the Ruby Mountains and the Toiyabe Range, have steep fronts, with sharply incised canyons and less steeply dipping back slopes. Others, including the Santa Rosa and Humboldt Ranges, are bordered by steep fronts along both sides of the range. Faulting is not apparent along some mountain fronts; however, the steeper slopes, as evidenced by the west face of the Cortez Range, are often bordered by faults. Glacial scouring and deposits occur in a few of the higher mountain ranges, most notably in the Ruby and Independence Mountains and the Toiyabe Range (see photograph 15).

The intermediate slopes or uplands include alluvial fans, pediments, terraces, benches, and some wave-cut and depositional features of former lakes. Alluvial fans emanate from the mouths of canyons and washes, and are composed of detritus eroded from higher slopes. Many are coalescent with other alluvial fans, and form continuous slopes or aprons flanking the mountains. Some are entrenched near their apexes, or are dissected by drainages. Several ages of fans occur. They are differentiated by such factors as degree of soil development, dissection, composition, stratigraphy, drainage pattern, and faulting.

Remnants of pediments (erosional surfaces) in the basin are developed on partially consolidated valley fill deposits, on unconsolidated sedimentary deposits, or as surfaces formed on consolidated bedrock. Surfaces forming the pediments are commonly veneered by gravel.

Features along the valley floors or lowlands include river terraces, floodplains, channels, playas, and shallow lakes.

Below Golconda, degradation by the Humboldt River has resulted in the formation of two river terraces below the lake plain of Lake Lahontan, while for some distance upstream from Winnemucca the river appears to be nearly at grade. Between Comus and Beowawe there is a relatively wide flood plain, with a well-developed meander pattern. Above Palisade Canyon, degradation appears to have been important as a factor in developing land forms. Valley fill in this area is extensively dissected in many places, and pediments, terraces, and benches are common. Mostly unconsolidated alluvial deposits on the valley floors are believed to be relatively thin throughout much of this area. (See Geology Map.)

Photograph 14. - Massive rhyolitic lava flows form the prominent Snowstorm Mountains rimrock on the west side of Clover Valley, which is visible in the middle distance. Battle Mountain Sub-Basin. FIELD PARTY PHOTO --- 6-785-9

Photograph 15. - Glacial scouring at the heads of Lee Creek (on the left) and Welch Creek, Ruby Mountains, in the sub-basin of that name. The rounded crest in the center back-ground is Ruby Dome, the highest point in the Rubies (11,349 feet). FIELD PARTY PHOTO --- 6-693-6

Photograph 16. - Identifying a soil by determining its characteristics. Humboldt River Basin. SCS PHOTO --- 6-586-5

Soils

The wide variation in climate, relief, vegetation, parent materials and age of landscapes within the Humboldt Basin has resulted in the occurrence of a large number of different kinds of soils. These soils represent members of approximately 12 Great Soil Groups, which portray broad differences in the factors responsible for their development. These Great Soil Groups correspond closely with definitions presented in the publication entitled Soils of the Western United States, published at Washington State University, September 1964.

The Soils Map of the basin included in this report identifies soils at two levels of generalization. The more generalized level, shown on the map by color separations, includes seven areas. The dominant Great Soil Groups within each of these areas are closely related, and the associated soils reflect similarities resulting from the broad impact of climate, relief, and vegetation. (See photograph 16.)

At the more specific level, associations of Great Soil Groups are identified by number and letter within the soil area color separations. This level of generalization shows the broad patterns of Great Soil Groups as they intermingle one with another on the landscape. The more generalized associations of Great Soil Groups indicate only the major dominant and associated soils. Inclusions of numerous other Great Soil Groups are typically present in each soil association delineated, but are not included in the name of the map units.

A brief description of each of these color separations follows:

Soil Area 1 - Light-Colored Soils of Arid Areas

This area occurs extensively on alluvial fans, terraces, and lower mountain slopes in arid portions of the river basin. Desert and Sierozem Soils are dominant, and are associated with Alluvial, Brown, Calcisol, Humic Gley, Lithosol, Regosol, and Solonetz Soils. The soils characteristically have light-colored surface horizons; contain low amounts of organic matter; and usually contain some alkaline earth carbonates and soluble salts.

Shrubs and scattered grass constitute the major vegetal cover, and the major use is for low-productivity grazing. A small portion of the area is used for irrigated cropland, but a large portion is potentially suitable for such use.

Soil Area 2 - Moderately Dark-Colored Soils of Semi-Arid Areas

This area occurs extensively on high terraces and plateaus, and on many of the mountainous uplands in the basin.

Brown Soils are dominant, and associated with Alluvial, Chestnut, Lithosol, Planosol, Regosol, Rockland, and Sierozem Soils. The soils typically have thin moderately dark-colored surface horizons; they contain horizons of alkaline earth carbonate accumulations, and have developed under a slightly wetter environment than those soils that dominate Soil Area 1. Shrub-grassland is the major vegetal cover, and the major use is for grazing. Productivity of the dominant soils in the area is moderately high.

Soil Area 3 - Dark-Colored Soils of Semi-Arid Areas

This soil area is of moderate extent in the mountainous northeastern headwaters section of the Humboldt Basin.

Chestnut Soils are dominant, and are associated with Brown, Lithosol, Regosol, Rockland, and small areas of Planosols and Prairie Soils. The soils typically have thick, dark-colored surface horizons, neutral reaction, and have been generally leached of alkaline earth carbonates. A large proportion of the soils occurring in the unit have moderately steep to very steep slopes, and varying amounts of gravel, cobble and stones on the surface and within the profile.

Shrub-grassland, with scattered juniper, is the dominant vegetal cover in the area. Major land uses include grazing, watershed, and some recreational use. The dominant soils in the area have a high potential for forage production, and include some of the best rangelands in the basin.

Soil Area 4 - Recent Alluvial Soils

This soil area occupies the recent fans, floodplains, and basins, and may be subject to periodic flooding.

Alluvial Soils are dominant, and are associated with Calcisol, Humic Gley, Sandy Regosols, Sierozem, Solonchak and Solonetz Soils. The outstanding characteristic of the dominant soils is the lack of or weak expression of soil development, and the great variability in textures because of stratification in the profile. In certain areas having restricted drainage soluble salts have accumulated, and calcium carbonate is usually present throughout the profile. The vegetation in this soil area is highly variable, because of climatic and soil differences.

The area is important in that it includes much irrigated cropland, and a considerable area having potential suitability for irrigated cropland. The larger portion is presently used for low-productivity grazing.

Soil Area 5 - Dark-Colored Wet Bottomland Soils

This area occupies a large portion of the poorly drained floodplain of the Humboldt River and its tributaries.

Humic Gley Soils are dominant in the area, and are associated with Alluvial, Desert, Calcium Carbonate Solonchak Soils, and a small area of Chestnut Soils. The outstanding characteristics of these soils include a thick black surface horizon, poor drainage, and medium to fine textures. Some areas contain soluble salts and considerable calcium carbonate. They generally occur on nearly level slopes, and are subject to overflow.

This soil area includes the major area of irrigated soils in the Humboldt River Basin. Most of the irrigated area is devoted to the production of meadow hay, but a large area in Lovelock Valley has been reclaimed and is used for cropland.

Soil Area 6 - Immature Soils on Unconsolidated Upland Materials and Aeolian Sands

This soil area occurs primarily in the mountainous portions of the basin. It includes, however, sandy wind-worked soils on terraces, alluvial fans, and some mountain slopes.

The area is dominated by Regosols. The sandy Regosols are associated with Alluvial and Desert Soils, and those of the mountainous areas with Chestnut, Brown, Lithosol, Rockland, and Sierozem Soils. The dominant soils have light to dark-colored surface soils which are underlain by relatively unmodified alluvium, colluvium, or aeolian materials.

Vegetation in the area varies considerably, from desert-shrub types to the subhumid shrub-grassland types. Major uses include grazing, watershed, and recreational use.

Soil Area 7 - Shallow Soils on Consolidated Upland Materials

This soil area occurs principally on the upper slopes and ridges of some of the steep, rugged mountain ranges in the basin.

Lithosols are the dominant soils in the area, and are associated with Brown and Regosol Soils, and small areas of Chestnut Soils and rock outcrops. The dominant soils have dark to light-colored surface soils, and are characteristically underlain by bedrock at less than 20 inches. Slopes are usually steep to very steep, and surfaces are stony or rocky.

The vegetal cover is variable, depending upon elevation and climate. Use is limited primarily to grazing, watershed, and recreation.

Climate

The climate of the Humboldt River Basin is generally considered arid to semi-arid, although there are a few mountainous areas with relatively high precipitation. The area is characterized by ineffective summer precipitation, low humidity, and high evaporation. Mean temperatures along the Humboldt Valley from April through September vary from 58 degrees F at Wells to 64 degrees F at Lovelock. During the colder months the mean temperatures vary from about 32 degrees F to 39 degrees F at these stations. Maximum temperatures of 100 degrees F and above have been recorded at stations along the Humboldt Valley during the months of June through September, and minimum temperatures of zero degrees F and below have been recorded during the months of November through February. Temperatures of 32 degrees F and below have also been infrequently recorded during the summer months.

The average growing season varies from about 130 days (32 degrees F) and 160 days (28 degrees F) at Lovelock to less than 20 days (32 degrees F) and 80 days (28 degrees F) in the irrigated areas of some of the upstream tributaries.

Precipitation

Average annual precipitation varies from a low of four inches in the lower end of Humboldt River, below Lovelock, to an estimated high of 50 inches in the Ruby Mountains, east of Elko. About 65 percent of the basin receives less than 10 inches of moisture. These data are based on Environmental Science Service Administration (former U.S. Weather Bureau) and State records at 85 precipitation stations, Federal-State-Private Cooperative Snow Survey records, and the Field Party's annual water balance study. (See Precipitation Map, and photograph 17.)

Photograph 17. - Forest Service and Soil Conservation Service snow surveyors weighing a snow sample on an Independence Mountains snow course, Humboldt National Forest. North Fork Sub-Basin. FIELD PARTY PHOTO

Most of the moisture falls in the form of snow during the winter and early spring. Very little precipitation falls during the summer months. Snowpacks in the mountainous areas, mostly above Palisade, are the primary sources of water for irrigation. Runoff can occur any time between the latter part of December through June.

Much of the basin is subject to violent convection storms of small areal extent and relatively high (compared to normal) intensity. These storms are often the cause of severe soil erosion and localized flood damage. Figure 1 is the storm track pattern for the State of Nevada.

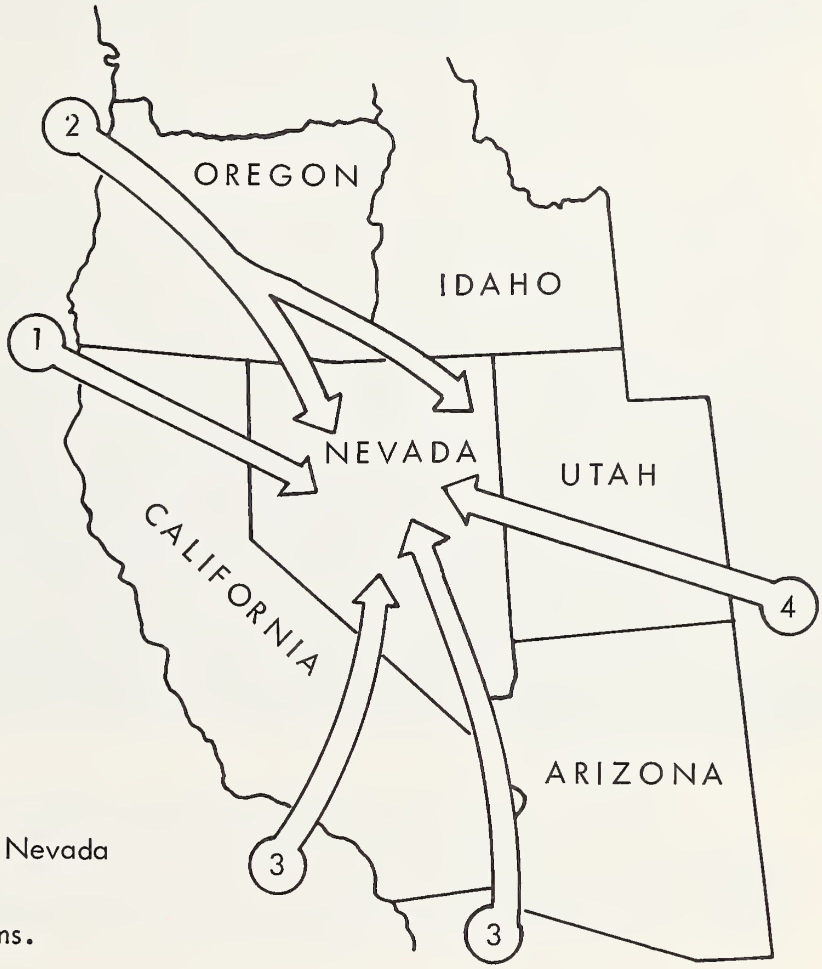


Figure 1. -- Storm track for Nevada

(1) Most frequent winter storms.

(2) Second most frequent winter storms

(3) Third most frequent winter storms - heaviest precipitation per individual storm.

(4) Summer thunderstorms from Gulf of Mexico - very little general precipitation, but locally high intensity.

SOURCE: ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION (U.S. WEATHER BUREAU)

General Cover Types

Vegetal cover types of the Humboldt River Basin, which is a part of the Great Basin Region, are presently dominated by deeply-rooted semi-desert shrubs, with an understory of perennial and annual grasses, a wide variety of forbs, and a few noxious or poisonous herbaceous species. Most of the grasses are members of the bromegrass, wheatgrass, bluegrass, ryegrass, or needlegrass genera; most of the shrubs and forbs belong to either the Chenopod or Composite families.

Twelve vegetal sites were mapped in the Humboldt River Basin (see table 1, and Vegetal Site Map.) The Upland Benches and Terraces site, together with the Intermediate Mountain Slopes site, are the principal vegetal sites where big sagebrush generally forms the aspect overstory, with various species and admixtures of annual and perennial grasses making up an understory of widely variant ground cover densities (see photograph 18). These two sites occupy 40 percent and 12 percent, respectively, of the total basin range area, or 5,452,000 acres. The shadscale-budsagebrush-grass on the Droughty Desert Uplands makes up the next largest range area, occupying approximately 14 percent of the total acreage, or 1,565,000 acres (see photograph 19). The Saline Bottomlands vegetal site, with rabbitbrush or black greasewood or a mixture of both composing the aspect species, is the third largest rangeland area, making up approximately eight percent of the basin, or 804,000 acres (see photograph 20).

The remainder of the Humboldt Basin consists of several vegetal sites, including: Alkali Bottomlands, semi-playa-greasewood; Wet Saline Bottomlands, salt cedar-greasewood-saltgrass; Alkali Flats, salt cedar-greasewood; Semi-Wet Meadows, meadow grasses-forbs-sedges; Silty Desert Flats, winterfat-budsage-big sagebrush; Claypan Benches, low sagebrush-grass; Shallow Stony Slopes, pinyon-juniper-grass; and Steep Mountain Slopes and Basins, browse-aspen-conifer-grass. Together, these sites make up the remaining 26 percent of the basin area. (See photograph 21.)

Irrigated Cropland in 1965 occupied about 240,000 acres, or 2.2 percent of the basin area (see photograph 22). Unsuitable, barren, and inaccessible rangeland, together with lakes, reservoir storage areas, railroads, and municipalities, account for approximately 507,600 acres.

As of the summer of 1964, there were 231,000 acres of range seeded to perennial grasses, mainly crested wheatgrass or Siberian wheatgrass. It is estimated an additional 1,019,000 acres can be successfully seeded, located principally on the flatter sagebrush slopes and alluvial fans of the Upland Benches and Terraces and the Claypan Bench vegetal sites. (See photograph 23.)

Generally, big sagebrush-grass is the dominant vegetation above Palisade, whereas shadscale and bud sagebrush comprise the aspect species on most of the upland slopes and benches along the lower river and its tributaries.

Black greasewood and rubber rabbitbrush, nonbeneficial phreatophytes, are found throughout the Humboldt River bottomlands, as well as on the bottomlands of many of the tributaries of the river. These phreatophytes, often with an understory of saltgrass, another nonbeneficial phreatophyte, commonly form a fringe to the hayland and pasture fields; they also may be present on the saline-alkali soils of many of the valley bottomlands where no cropland exists. Rubber rabbitbrush is the dominant phreatophyte above Palisade, while black greasewood is more prevalent below that point. Approximately nine-tenths of the total phreatophyte area lie below Palisade, with one-tenth being found above that location.

Photograph 18. - Big sagebrush-grass vegetal site, Packer's Field at the mouth of Rock Creek, Battle Mountain Sub-Basin. Thurber needlegrass is the principal grass species present, with varying amounts of squirreltail, Sandberg bluegrass, needle-and-thread, Indian ricegrass, western wheatgrass, and Great Basin Wildrye.

FIELD PARTY PHOTO --- 8-BM

Photograph 19. - A rare example of shadscale-bud sagebrush-grass vegetal site in the fairly high forage production class. Upper Grass Valley, Sonoma Sub-Basin; grasses present in the understory are Sandberg bluegrass, squirreltail, and Indian ricegrass.

FIELD PARTY PHOTO --- 2-S

Photograph 20. - The Saline Bottomlands vegetal site as it should appear: a luxuriant ground cover of Great Basin wildrye, creeping wildrye, and alkali sacaton. Garvey Ranch, Paradise Valley, in the Little Humboldt Sub-Basin. SCS PHOTO --- AGR-1074

Table 1. -- Acreage of present annual usable forage plant production classes for each vegetal type and site, Humboldt River Basin.

Vegetal type and site	Forage production classes (acres)			Total (acres)	Percent of basin area
	Fairly high	Medium	Low		
1. Rabbitbrush-greasewood-grass; saline bottomlands	7,700	55,300	741,320	804,320)	7.5
(range seeding)	6,600	1,900	-------	8,500)	
2. Semi-playa-greasewood-pickleweed, alkali bottomlands	-----	------	94,100	94,100	.9
3. Salt cedar-greaswood-saltgrass; wet saline bottomlands	-----	------	9,200	9,200	.1
4. Salt cedar -greasewood; alkali flats	-----	------	35,700	35,700	.3
5. Meadow grasses-forbs-sedges; semi-wet meadows	47,200	31,200	65,700	144,100	1.3
6. Big sagebrush-grass; upland benches and terraces	44,835	473,770	3,628,950	4,147,555)	40.1
(range seeding)	198,965	24,060	-------	223,025)	---
7. Shadscale-grass; droughty desert uplands	1,200	63,600	1,499,800	1,564,600	14.3
8. Winterfat-budsage-big sage-grass; silty desert flats	-----	------	15,600	15,600	.2
9. Low sagebrush-grass; claypan benches	43,600	151,900	365,900	561,400	5.1

Continued

Table 1. -- Acreage of present annual usable forage plant production classes for each vegetal type and site, Humboldt River Basin -- Continued

Vegetal type and site	Forage production classes (acres)			Total (acres)	Percent of basin area
	Fairly high	Medium	Low		
10. Browse-aspen-grass; intermediate mountain slopes	83,000	367,100	854,600	1,304,700	12.0
11. Pinyon-juniper-grass; shallow stony slopes	22,900	112,300	430,500	565,700	5.2
12. Browse-aspen-conifer-grass; steep mountain slopes and basins	60,000	287,000	314,800	661,800	6.1
Subtotal	516,000	1,568,130	8,056,170	10,140,300	(93.1)
Unsuitable, barren, and playa 1/				456,300	4.2
Irrigated cropland, 80 percent frequency				240,000	2.2
Highways, railroads, municipalities, and area in lakes and reservoirs				51,300	.5
Total basin acreage				10,887,900	100

Footnote 1/ Because of the continuing development of the acreages of unsuitable, barren, and inaccessible land, the acreages totaled from the individual sub-basin reports will not agree with this total, which is based upon more recent and realistic appraisals and deductions for this type acreage.

Source: Humboldt River Basin Field Party

Photograph 21. - Browse-aspen-conifer grass, Steep Mountain slopes and Basins vegetal site. Upper Lamoille Canyon, Humboldt National Forest, in the Ruby Mountains Sub-Basin. FS PHOTO --- 513061

Photograph 22. - This high-producing hay field in Lamoille Valley, Ruby Mountains Sub-Basin, is a prime example of the better cultivated areas of the Humboldt Basin. SCS PHOTO --- 6-166-5

Photograph 23. - A formerly depleted big-sagebrush grass vegetal site plowed and seeded to crested wheatgrass. William Hylton Ranch, Starr Valley, looking eastward toward the East Humboldt Range. Ruby Moutains Sub-Basin. SCS PHOTO --- F-195-12

Photograph 24. - Phreatophytic rubber rabbitbrush has taken over this Saline Bottomlands site on upper Fish Creek, Shoshone Range, Reese River Sub-Basin.

FIELD PARTY PHOTO --- 6-789-10

Great Basin wildrye, alkali sacaton, fourwing saltbush, and creeping wildrye, the chief beneficial phreatophytes, occupying 104,000 acres (natural stand densities and 100 percent phreatophyte species composition), are often close associates of the rabbitbrush-greasewood stands. In addition, creeping wildrye, along with other grasses, forbs, sedges, and clovers which are able to withstand a fluctuating water table, occasional flooding, and no more than mild concentrations of salt and alkali, are the chief species cut for hay.

On some of the river bottomlands, but more particularly from Palisade to Iron Point, Great Basin wildrye, alkali sacaton, and saltgrass grow in admixture stands, with few or no shrub species present. These grassland areas along this portion of the Humboldt River bottomlands are high-producing, reaching approximately 3,000 pounds of total herbage per acre.

Total area occupied by all phreatophytes (natural stand density and 100 percent phreatophyte species composition) is approximately 619,500 acres (see Phreatophyte Map). As previously noted, black greasewood and rubber rabbitbrush are the dominant phreatophytes, occupying 306,000 acres and 88,000 acres, respectively. Willow, more often than not a nonbeneficial phreatophyte, covers approximately 9,400 acres in the Humboldt Basin. Other phreatophytes of lesser significance are wild rose, silver buffaloberry, salt cedar (smallflower tamarisk), quailbrush, cottonwood, and seepweed. (See photograph 24.)

Table 2. -- Calculated water yield and contribution to Humboldt River by sub-basins (surface and subsurface flow)

Sub-Basin	50% chance		80% chance	
	Water yield (acre-feet)	Contribution to Humboldt River (acre-feet)	Water yield (acre-feet)	Contribution to Humboldt River (acre-feet)
1 Little Humboldt	75,000	3,500	41,000	3,000
2 Pine Valley	23,000	7,500	17,000	5,000
3 Ruby Mountains	283,000	165,000	210,500	100,500
4 Mary's River	56,000	31,000	38,000	20,500
5 North Fork	61,000	37,000	40,000	18,000
6 Maggie Creek	21,000	14,500	12,000	6,500
7 Elko Reach	1,000	500	500	500
8 Reese River	52,000	None	32,000	None
9 Battle Mountain	39,000	6,000	21,500	3,000
10 Sonoma	22,000	11,000	10,500	10,500
11 Lovelock	7,000	5,000	4,500	3,000
Total	640,000	281,000	427,000	270,500

Source: Humboldt River Basin Field Party

Water Supply

The need for an overall water inventory became apparent shortly after the beginning of the Humboldt River Basin Survey, because over much of the area only meager climatological, streamflow, and related data were available. It was necessary, therefore, for the Field Party to develop techniques for an annual water balance inventory, in order to present a complete picture of the quantity of available water, and water uses and losses. The procedure developed utilized data on climate, soils, vegetation, and geology, as well as stream flow and physical features. Starting with incident precipitation on the watershed, annual water balance calculations were made for all watersheds in the Humboldt Basin for 80 percent (equaled or exceeded eight out of 10 years) and 50 percent frequencies (chance), and for average conditions in a few sub-basins.

The decision to express annual water yield values in terms of percent chance rather than averages was predicated on two factors: (1) many streams within the basin have extreme variation between their high and low values of annual yield. Based upon a log-normal distribution of annual values, a typical stream in a droughty area may experience a yield equal to or greater than the "average" only one year out of four, whereas in high-yielding areas the average and 50 percent chance value (equalled or exceeded one year out of two) may be quite comparable. The use of specific probability, rather than an average, permitted direct comparisons of values having a similar percent chance of occurrence. (2) Because of the considerable variation in length of available stream flow records, it was not practicable to extend all records to a common base period, particularly since reasonably reliable frequency curves could be developed in some cases with a fairly short period of record. Fifty percent chance values are presented except as otherwise noted.

The water balance studies indicated that within the Humboldt River Basin a minimum of 9.3 million acre-feet of precipitation occurs five years out of ten (50 percent chance). Less than 7 percent of this precipitation--about 640,000 acre-feet--shows up as water yield and only about 281,000 acre-feet is contributed directly to the Humboldt River. The remainder is retained on the watersheds for on-site uses, or lost from the basin. Above Palisade, about 12 percent of the precipitation becomes water yield; below that point, about four percent. About two-thirds of the water yield originates above Palisade, an area which contains about one-third the acreage of the basin. It is of interest that the Ruby Mountains and East Humboldt Range contribute about 44 percent of the water yield of the Humboldt Basin (see photograph 25). Table 2 indicates the water yield and contribution to the Humboldt River by sub-basins for 50 to 80 percent chance.

Water yield, or gross water yield, as used in the sub-basin reports, is the estimated available water, both surface and subsurface, prior to agricultural and phreatophytic use. Water yield from 65 percent of the Humboldt Basin is negligible; less than 0.1 inch per acre, except during periods of high precipitation. This low-yielding area consists, in general, of the alluvial fans and bottomlands at the lower elevations. In contrast, a relatively small area (estimated 10,000 acres) above 10,000 feet in elevation on Lamoille, Rabbit, and Tenmile Creeks in the Ruby Mountains yields more than 30 inches per acre (see Water Yield Map).

There are a number of thermal springs in the basin having annual flows ranging from a few acre-feet to an estimated 4,000 acre-feet. The sources of most of these springs are not known. These springs have relatively stable base flows through a cycle of wet and dry years, and therefore may have some effect upon the gross water yield from the watersheds where they are located. This effect would be similar to that of a surface reservoir having carryover storage from wet years to dry years.

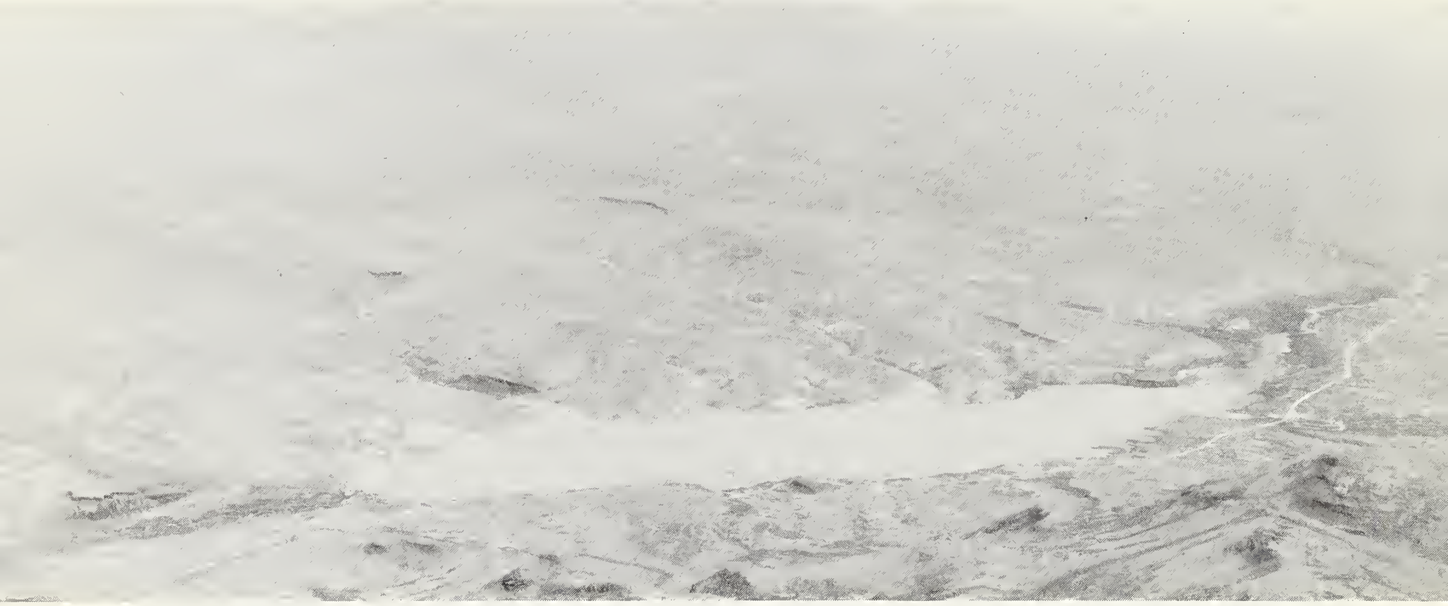
The water balance calculations indicated a loss of water from the Humboldt Basin through fault planes and related fractures in the limestone formation of the Ruby Mountains south of Harrison Pass. This loss of water from the west slope to the east slope of the Rubies was substantiated by a geologic investigation made by the University of Nevada. The Field Party estimated this interbasin transfer of water to be about 13,000 acre-feet for a 50 percent chance.

Figure 2 is a sketch of the Humboldt Basin, showing by areas the computed gross water yield and the quantity of water which flows into the Humboldt River, both surface and subsurface. Runoff usually occurs in the spring and early summer, and at that time water supply is generally in excess of immediate upstream requirements. During most of the summer, however, when plant requirements are high, streamflow in most of the drainages is low, and is insufficient to meet the need for domestic and agricultural use. This is true especially where irrigation is dependent upon direct diversion from natural streamflow. Late irrigation water shortages usually are quite severe, and limit the agricultural development and production in most of the basin.

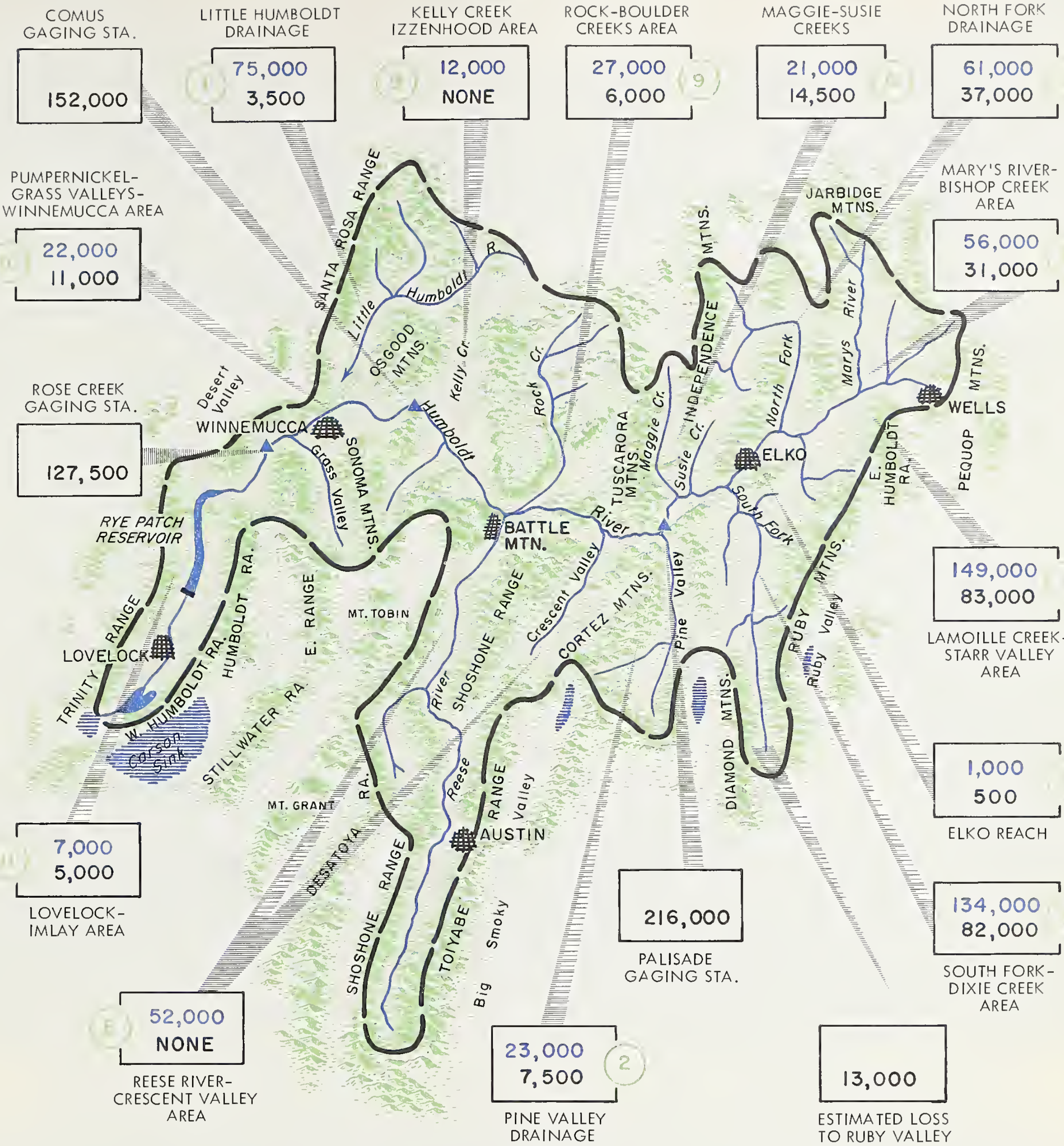
Presently, there is only limited regulation of streamflow in the basin. There are three relatively large reservoirs which are used to store water for irrigation: Rye Patch, 192,000 acre-feet; Willow Creek, 18,000 acre-feet; and Bishop Creek, 11,000 acre-feet (see cover photograph and photographs 26 and 27). The Pitt-Taylor Reservoirs, presently restricted to 25,000 acre feet, are used only when runoff is great enough to assure the filling of Rye Patch. In addition, there are numerous small reservoirs ranging in capacity from a few acre-feet to 900 acre-feet. All reservoirs, except Rye Patch, Pitt-Taylor, and Bishop Creek, store water for individual ranch operations.

Photograph 25. - Upper South Fork of the Humboldt River, Ruby Mountains Sub—Basin, one of the prime contributors to the flow of the Humboldt River. SCS PHOTO --- 6-764-11

Photograph 26. - Aerial view of Willow Creek Dam and Reservoir, Battle Mountain Sub-Basin, looking northerly. FIELD PARTY PHOTO --- 6-694-8



Photograph 27. - Bishop Creek Dam and Reservoir, Mary's River Sub-Basin, looking down Emigration Canyon. SCS PHOTO --- F-391-5



LEGEND

60,000 / 30,000	GROSS WATER YIELD, both surface and subsurface (acre-feet). OUTFLOW TO HUMBOLDT RIVER, both surface and subsurface (acre-feet), or LOSS TO RUBY VALLEY (acre-feet), or FLOW AT STREAM GAGING STATION (acre feet).
(8)	SUB-BASIN REPORT NUMBER

FIGURE 2

WATER RESOURCES (50 Percent Chance)

HUMBOLDT RIVER BASIN

NEVADA

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

USDA SCS PORTLAND OREG 1965 M-4474

Photograph 28. - Pure, snow-fed waters of Lamoille Creek, one of the Humboldt's upper sources, in the Ruby Mountains Sub-Basin. FS PHOTO --- 513055

Annual streamflow from all drainages fluctuates widely from year to year. As an example, gaging records on the Humboldt River at Palisade indicate a maximum annual discharge of 636,000 acre-feet in 1952 and a minimum of 25,000 acre-feet in 1934; average annual discharge (1903-1906, 1912-1964) is 256,300 acre-feet. During this period of record there were 25 years when the annual discharge was above average, and 32 years below. The maximum peak flow at Palisade was 6,600 c.f.s. on February 12, 1962, and the lowest flow was two c.f.s. on August 25-28, 1931.

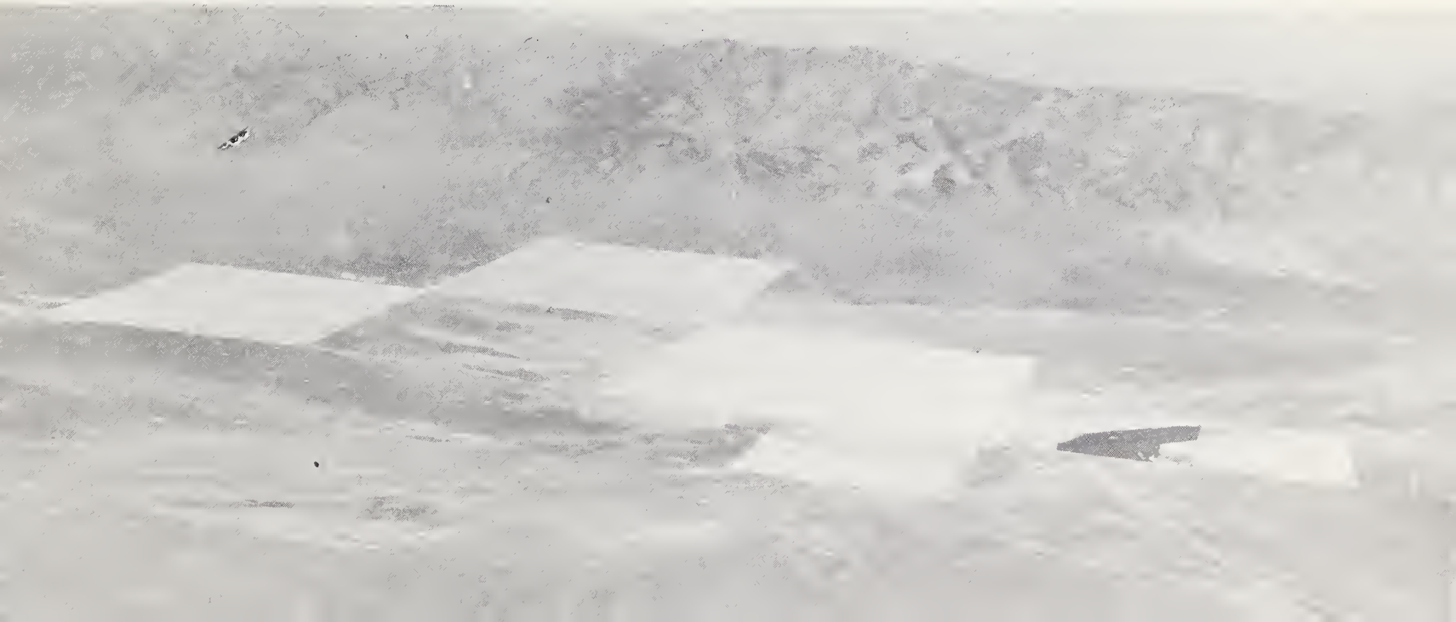
The river water, starting as pure water from melting snows on the watershed, progressively deteriorates in quality as it moves downstream (see photograph 28). Salts are picked up in the return of irrigation waters, and from the wetted areas of the floodplain where these salts have been concentrated by evaporation and transpiration. The water which reaches Lovelock is further salinized as a result of evaporation from Rye Patch Reservoir (see photograph 29). Water flowing into Rye Patch Reservoir varies in quality throughout the year, as well as from year to year, depending upon the flow in the river. Usually, this water is of low to medium salinity, and of low to medium sodium hazard, and contains approximately 300 to 500 parts per million total dissolved salts. Water released from Rye Patch Reservoir during the irrigation season is generally of medium to high salinity, and of low to medium sodium hazard. It contains approximately 600 to 900 parts per million total dissolved salts. The salts in both the inflow and released waters from Rye Patch consist of 50 to 60 percent sodium cations, and 45 to 70 percent bicarbonate anions.

Drainage waters which leave the Lovelock irrigated area are further salinized by evapotranspiration in Lovelock Valley, and by the pickup of salts deposited in the soils during previous years. Such drainage waters are doubtful to unsuitable in quality for irrigation.

The total amount of ground water in storage in the Humboldt River Basin as a potential water supply is not known. Limited studies made to date by the U.S. Geological Survey indicate the probability that the quantity is many times the average annual water yield. Some of this ground water is of satisfactory quality for irrigation and domestic use, and some is not suitable, primarily because of the quantity of dissolved salts. At the present time a relatively small amount of water is being pumped from ground storage. In 1964, 17,000 acres of alfalfa and grain were entirely pump-irrigated, and, in addition, supplemental water was pumped for 7,000 acres of these crops (see photograph 30). Factors affecting the development of ground water as a water supply include: (1) the effect on water rights of others; (2) the available recharge; (3) the effect of pumping on use of water by phreatophytic plants; and (4) costs of installation and operation of the wells.

Photograph 29. - At this stage of their journey to the Humboldt lakes and the Humboldt-Carson Sink, the waters of the Humboldt River are considerably more salinized and lower in quality than in the preceding photograph. Humboldt main channel below Rye Patch Dam, Lovelock Sub-Basin. FIELD PARTY PHOTO --- 6-862-3

Photograph 30. - Pump-irrigated grain and alfalfa field, Grass Valley, Sonoma Sub-Basin.
FIELD PARTY PHOTO --- 6-694-12



Land Ownership Status

There are approximately 1,100 land owners in the Humboldt Basin, not including lands within the boundaries of municipalities, small communities, or other small tract subdivisions. The ownership record has been compiled from data of the Bureau of Land Management, the Soil Conservation Service, and the Pershing County Water Conservation District. About two-thirds of the Humboldt Basin are in Federal ownership, and one-third in private. The Bureau of Land Management administers 6,405,000 acres, or 59 percent of the land within the basin. The Forest Service administers 701,000 acres, or about 6.4 percent. Responsibility for the remainder of the Federal land is lodged with the Bureau of Reclamation and the Bureau of Indian Affairs. The Bureau of Reclamation controls 102,900 acres, and approximately 21,600 acres are held in trust by the Bureau of Indian Affairs for various Indian tribes and colonies.

Ownership of private lands amounts to approximately 3,620,000 acres, with the Southern Pacific Land Company the largest single owner (752,000 acres). County and State lands amount to approximately 30,000 acres; municipalities account for another 7,800 acres.

Sections of Federal and private lands are intermingled in a checkerboard pattern for 20 miles on either side of the original Central Pacific right-of-way along the Humboldt River, which is now the approximate route of the Southern Pacific Railroad. Large solid blocks of private land occur all along the bottomland of the Humboldt River, as well as on many of its tributaries. Desert entries in the past ten years have accounted for approximately 35,000 acres passing into private ownership; this acreage is principally in the Reese River Sub-Basin. (See Land Status Map.)

The approximate land status breakdown is as follows:

	Acres	Percent
Public Domain	6,404,600	59.0
National Forest	701,300	6.4
Reclamation Land	102,900	0.9
Indian Lands	21,600	0.2
Subtotal	7,230,400	66.5
Private	3,620,000	33.2
County and State	29,700	0.3
Municipalities	7,800	---
Subtotal	3,657,500	33.5
Total	10,887,900	100.0

Land Use

Land in the Humboldt Basin, whether it is privately owned or administered by Federal agencies, is used for many different purposes, but by far the greatest use is to furnish some type of feed for livestock. This use encompasses spring, summer, fall, and winter range, winter and summer pasture, cropland, and aftermath grazing on cropland. In addition, a small acreage, principally in the Lovelock Valley, is devoted to livestock feeding operations. Other uses of land are for municipalities, roads, recreation sites, farmsteads, railroad rights-of-way, mining, and reservoir water storage areas. However, less than one percent of the total Humboldt Basin area is used for these purposes, but nearly all the land is used for more than one purpose. Most of the higher elevation lands serve as watershed areas, and all the land in the Basin furnishes a habitat for some form of wildlife.

Both the Forest Service and the Bureau of Land Management, who administer approximately 66 percent of the land, are directed to manage their lands for sustained yield and multiple use. The programs of these agencies encourage land exchanges, special use permits, and exchange of use agreements, in order to establish a more unified land pattern for better management.

The heaviest use of the range lands occurs in the summer and fall when livestock are grazed, and when recreationists, hunters, and fishermen pursue their various activities. Except for the big game, upland game birds, and other wildlife use, most of the rangeland receives little use during the winter months.

Cropland harvested each year varies, depending upon the flow of water in creeks and rivers, and the amount of water stored in reservoirs.

The approximate acreage of land for most of the various uses is tabulated as follows:

Rangeland (private and Federal)	10,140,400	
Cropland	240,000	1/
Municipalities	7,800	
Reservoir storage areas	12,000	
Unsuitable, barren, inaccessible, playa	456,300	
Railroad rights-of-way	7,000	
Highways and roads	18,700	
Lakes	5,800	
Total	10,887,900	

1/ Cropland harvested in 1965

Water Use

About 93 percent of the estimated 9,285,000 acre-feet of moisture that falls in the Humboldt River Basin during a 50 percent chance year is used by the grasses, shrubs, and trees which grow on the watershed lands, or is evaporated from the land surface. The remaining seven percent is used on irrigated land in the tributary valley bottomlands, irrigated alluvial fans, and along the flood-plain of the Humboldt River.

Table 3. -- Phreatophyte acreage and annual ground water use, Humboldt River Basin 1/

Species	Tributary area		Humboldt River main stem		Humboldt River Basin	
	Acres	Acre-feet	Acres	Acre-feet	Acres	Acre-feet
Nonbeneficial						
Tamarisk (salt cedar)	-----	-----	3,200	8,800	3,200	8,800
Cottonwood	1,200	4,800	100	500	1,300	5,300
Willow	5,700	12,700	3,700	8,300	9,400	21,000
Black greasewood	126,800	32,000	179,100	41,300	305,900	73,300
Rubber rabbitbrush	66,100	23,100	21,700	6,500	87,800	29,600
Alkali seepweed	8,200	4,100	21,900	11,000	30,100	15,100
Saltgrass	34,400	17,200	34,600	17,300	69,000	34,500
Quailbrush, cattail, bulrush, pickleweed, rose, buffaloberry	3,600	5,300	4,400	3,300	8,000	8,600
Subtotal	246,000	99,200	268,700	97,000	514,700	196,200
Beneficial						
Great Basin and creeping wildrye	31,500	30,000	40,600	40,600	72,100	70,600
Alkali sacaton	17,500	8,800	10,100	5,000	27,600	13,800
Fourwing saltbush	-----	-----	4,800	2,400	4,800	2,400
Subtotal	49,000	38,800	55,500	48,000	104,500	86,800
Total, range phreatophytes	295,000	138,000	324,200	145,000	619,200	283,000
Wet meadow	38,800	16,200	18,300	8,400	57,100	24,600
Alfalfa	3,000	1,500	15,600	15,300	18,600	16,800
Total, cropland phreatophytes	41,800	17,700	33,900	23,700	75,700	41,400

1/ These values are based on natural stand densities and 100 percent composition for each phreatophyte species, except for the irrigated and wet meadows.

Source: Humboldt River Basin Field Party.

Use of water by nonbeneficial phreatophytic plants amounts to an estimated 196,000 acre-feet annually, or about 27 percent of the annual yield. These plants consist primarily of greasewood, rabbitbrush, willow, salt cedar, and saltgrass. Approximately one-half this use occurs along the main stem of the Humboldt, and the other half on tributary drainages. (See table 3.)

Beneficial phreatophytes, which are mostly Great Basin and creeping wildrye, Alkali sacaton, and fourwing saltbush, use an estimated 87,000 acre-feet of water annually, or about 12 percent of the annual yield.

The estimated distribution and total use of water for a year having a 50 percent chance annual yield is shown in the tabulation which follows. The values in the tabulation are based on conditions, acreage irrigated, etc. that were found to exist at the time this investigation was made. Some of the lands with water rights are presently not being harvested. This is a temporary condition in most cases, and may be ascribed to economic or other factors. Other lands are not harvested because of poor soils or late water rights, and therefore may be considered as abandoned cropland.

	Area above Palisade (acre-feet)	Area below Palisade (acre-feet)	Basin total (acre-feet)
Irrigated crops	149,000	195,000	344,000
Phreatophytes	45,000	238,000	283,000
Loss from the basin 1/	13,000	-------	13,000
Municipal use	1,000	1,000	2,000
Evaporation (all sources)	5,000	89,000 2/	94,000
Total 3/	213,000	523,000	736,000

1/ Estimated loss to Ruby Valley.
2/ Includes 500 acre-feet of outflow to the Humboldt-Carson Sink.
3/ Part of the water is supplied from ground water in storage and carryover storage from reservoirs; therefore, these totals do not represent the gross water yield.

Water balance studies indicate that about one-half (estimated 49 percent) of the total water uses and losses occur along the Humboldt River floodplain. The remainder (51 percent) is used in the tributary drainages. The studies further indicate that 85 percent of the uses and losses along that portion of the Humboldt floodplain below Palisade is supplied by outflow from the upper basin.

Consumptive use of water by native meadow hay and pasture plants varies from eight to 26 inches. This wide variance is caused by the change in annual precipitation; in available water, both surface and subsurface, from dry years to wet years; by the difference in site location; and by species composition differences. The basic consumptive use requirements of a few representative crops grown along the Humboldt River are shown in the following tabulation:

Location	Annual comsumptive use (inches of water) Alfalfa	Improved meadow	Spring grain
Lovelock	31	28	18
Battle Mountain	29	27	17
Wells	24	21	16

The above values were computed using the Blaney-Criddle Improved Coefficient Method. Actual water requirements may vary from year to year, depending upon such factors as (1) average monthly temperatures; (2) planting and harvesting dates; (3) occurrence of frost in the late spring or early fall; (4) the depth to a water table; and (5) water management practices used.

Irrigation water requirements differ from actual plant needs, primarily because it is impossible, under field conditions, to obtain 100 percent irrigation efficiency. Such things as carryover moisture in the soil, effective summer precipitation, leaching requirements, available ground water, and crop yield potential, will affect the amount of water to be applied.

Water is also used by livestock, wildlife, and for a few camp and picnic developments. These uses are estimated to be in the range of 900 to 1,200 acre-feet annually. Rye Patch is the only reservoir in the basin presently being used for boating, water skiing, and swimming. This water, along with other reservoirs, ponds, and streams, provides fish habitat.

No attempt was made to determine the amount of water being used in the basin by such large mining operations as Newmont and Duval.

Water Rights

Surface waters in the Humboldt Basin might be considered over-appropriated in the sense that normally there is an insufficient supply to satisfy all the water rights. The distribution of water on the lower part of the Humboldt River main stem - including the reach of the river from Lovelock to Palisade, but excluding Grass Valley, the Little Humboldt, the Kelly Creek area, Reese River, and certain lands between Argenta and Palisade - was established by the Bartlett Decree (1931), and permits granted by the State Engineer as directed by the decree. Judge Bartlett recognized the doctrine of relations, under which the priority of a claim on a piece of land was dated from the time when construction was started on facilities to irrigate the land. Judge Edwards, whose decree for that portion of the Humboldt Basin above Palisade, as well as certain lands between Argenta and Palisade was issued in 1935, did not recognize this doctrine; however, he did allow certain lands to be bracketed. Under this arrangement, water to the amount allocated could be used on any land contained in a bracket. Allowances for certain permits, issued or to be issued by the State Engineer, were contained in the Edwards Decree.

On that portion of the Humboldt River Basin covered by the Bartlett and Edwards decrees, there are about 666,680 acre-feet of decreed and permitted water on 265,790 acres of land. This acreage does not include the Little Humboldt, Crescent Valley, Reese River, and some other areas tributary to Humboldt River which are covered in the sub-basin reports. The State Engineer recognizes that there is a discrepancy between the above figures and those given in the summation of the Bartlett Decree. Differences are explained by (1) duplications in the decree, (2) some permitted rights are not shown in the decree, and (3) some water rights have been transferred from the Imlay and Battle Mountain districts to the Lovelock area, with a corresponding reduction in the irrigated land.

The water rights on the Little Humboldt River and its tributaries were determined by the Carville Decree of 1935. This decree followed the general trends of the decrees on the main stem of the Humboldt, which provide for a flow of 1.0 c.f.s. per 100 acres of land. When water is available, the Carville Decree provides for the delivery at this rate of flow for 180 days for Class A rights, from April to September 27, or a total diversion of 3.6 acre-feet per acre. Class B rights are for 90 days, April 1 to June 29, or for a total of 1.8 acre-feet per acre. Class C rights are for 45 days, April 1 to May 15, or for a total of 0.9 acre-feet per acre.

Along the Little Humboldt River and its tributaries, there are by decree 30,361 acres of land with Class A, 1,539 acres with Class B, and 10,087 acres with Class C water rights, totaling 41,987 acres of land with water rights. Distribution is entirely separate from that on the main stream, although it is under the general supervision of the State Engineer and of a commissioner appointed for the entire Humboldt River system.

No search was made of the records in the State Engineer's office to determine the total acres of land of record with decreed, vested, and certified rights. There is no record in the State Engineer's office, or elsewhere, of vested rights. Further, permits are issued by the State Engineer for water development, and certificates are then issued based upon the amount of land actually irrigated. There are many areas where the acreages of land with vested rights have never been determined. Also, there are permits that have not yet come to final proof. Therefore, the determination of the actual acreage of land with water rights, or the acreage of land actually irrigated, becomes a question to be answered by the best judgement of the individual or group concerned. In this case, the Field Party estimated that about 340,000 acres in the Humboldt Basin have a water right of some kind.

Some of the features pertaining to most of the water rights which are of interest include:

1. Water belongs to the public.

2. The first in order of time is the first in order of right, according to the date of relative priority.

3. Water rights are appurtenant to the land. Under the Bartlett Decree, use is confined to specifically described land, while in certain instances under the Edwards Decree use is allowed on any land in bracketed groups of legal sub-divisions.

4. Water rights are assigned by all the decrees to three classes of land. On the main river these classes are:

   Class A - Harvest Crops - This is acreage usually cut for hay or used for cultivated crops, which is entitled to three acre-feet per season. The date of use extends from March 15 to September 15 below Palisade, and April 15 to August 15 above Palisade.

Photograph 31. - Measuring water at or near the point of use by means of a Parshall flume.
SCS PHOTO --- 6-219-12

Class B - Meadow Pasture - Grassland free from brush, which is used for pasture and entitled to one and one-half acre-feet per season. The date of use extends from March 15 to June 13 below Palisade, and April 15 to June 15 above Palisade.

Class C - Diversified Pasture - Brushland used for pasture, entitled to three-fourths acre-foot per season. The date of use extends from March 15 to April 28 below Palisade, and April 15 to May 15 above Palisade.

5. Water is measured at the point of use, or as near to that point as practical (see photograph 31).

6. Surface water of the Humboldt River system is fully appropriated.

7. The State Engineer or his designated representative is officially an employee of the district court in the distribution of the waters under a court decree.

Return flow from upstream irrigation is considered by the State Engineer to be part of the natural streamflow, and is so recognized in the various decrees. Under this concept, returning water becomes an important factor in setting priority of use throughout the basin, as well as the water supply available to any one user. Changes have been taking place on the watershed since livestock were introduced about 1870, and in recent years changes and improvements in water distribution systems and land development have been made throughout the basin which have had varying effects upon the return flow.

Some of the improvements can be considered beneficial, inasmuch as they have improved water use efficiency. Other changes, however, have merely acted as another obstruction to the natural flow of the stream.

With modern machinery, fields have been smoothed, sloughs which formerly returned water to the main channel have been dammed, and ditches have been extended farther from the main channel, to better serve cropland with existing water rights. The effect of the developments which have taken place over the past 75 years on the flow of the Humboldt River is very difficult to determine. There also have been improvements in the techniques of measuring water which raise questions regarding the reliability of some of the earlier estimates of discharge. Great fluctuations in water supply, which are common to the Humboldt River Basin, ranging from severe droughts of several years' duration to severe flood conditions, make identification of a normal discharge at Palisade extremely difficult.

Irrigation Methods

Methods of irrigation in the Humboldt Basin vary, depending primarily upon the nature of the water supply. About 75 percent of the cropland in the basin is irrigated by semi-controlled wild flooding (see photograph 32). These lands are located on the floodplains of the Humboldt River and tributary streams, where the water can be diverted from the stream channel directly to lands growing meadow hay or pasture. Water supply is limited to spring runoff, with comparatively little control of the quantity diverted. Under these conditions, the land may be flooded for many days at a time. This cropland is generally considered to be unimproved; however, smoothing has been done on some of the fields to facilitate water spreading. Ditches are used to convey water to high spots in fields.

The remaining 25 percent of the cropland has been improved by land leveling (see photograph 33). Most of this land is in the Lovelock area, where the water supply is usually available throughout the irrigation season from storage in Rye Patch Reservoir. Other areas where improved irrigation methods have been developed are located along perennial streams, or where well water has been developed in sufficient quantities for season-long irrigation. Water is applied to most of these lands by the border method of irrigation. These lands are either on the fringes of the floodplain where seasonal high water flooding is infrequent, are protected from natural flooding, such as in the case of Lovelock Valley, or are out of the floodplain, on alluvial fans. Some of these improved lands, growing seed or other row-crops, are furrow-irrigated; however, outside of Lovelock Valley this acreage is small.

THE AGRICULTURAL INDUSTRY

The Humboldt River Basin is located in north-central Nevada. Parts of five counties (Elko, Humboldt, Lander, Eureka and Pershing) comprise the major portion of the basin. Three other counties (Nye, White Pine and Churchill) also extend into the basin, but have little significance from the standpoint of agricultural production.

Little data was available for the basin per se; therefore, county data were used to present relationships which exist between the State and the five major counties in the basin. Whenever possible, figures pertaining to the basin were used.

Photograph 32. - Meadow-hayland being irrigated by the semi-controlled wild flooding methods commonly used in the Humboldt Basin. Humboldt main stem between Dunphy and Argenta, Battle Mountain Sub-Basin. FIELD PARTY PHOTO --- 6-838-9

Photograph 33. - Finished land-leveling with a tractor and land plane. Paradise Valley, Little Humboldt Sub-Basin. SCS PHOTO --- 6-108-7

Photograph 34. - Typical headquarters buildings of a large livestock ranch in the Humboldt Basin. McKinley Ranch, in the Elko Reach 10 miles west of Elko, with Grindstone Mountain looming to the southward. FIELD PARTY PHOTO

The Humboldt River Basin can be divided into three economic areas: (1) the area above Palisade, (2) Palisade to Comus, and (3) Comus to the Humboldt lakes and playa. The upper area has above-average range forage production for the basin, but a short growing season, with longer than average winter feeding. The central portion has generally lower range forage production than the area above Palisade, but a longer growing season, with some year-long range in the south central area. In the third and westernmost section of the basin, more diversified ranching and farming takes place. In this section the Bureau of Reclamation has developed the Humboldt Project in Pershing County, to stabilize the water resources of Lovelock Valley. This increased water supply has enabled farmers in the project area to engage in more intensive agriculture, such as raising sugar beets, and corn for silage.

Although these areas have slightly different production potentials, they are all tied together by the livestock industry, which is common and predominant throughout the Humboldt Basin (see photograph 34).

Population, Employment, and Income

Population data for the basin are not available; therefore, data for the five major counties (Elko, Eureka, Humboldt, Lander and Pershing) in the basin were used. The portion of these counties outside the basin is classified as rural, and is very sparsely populated.

In 1960 there were 23,251 individuals residing in the five basin counties. Rural population comprised 58 percent of the total population. Only about 22 percent of the rural population was classified as farm population in 1960. The following tabulation shows total urban and rural population for 1960:

	Population			
			Rural	
Item	Total	Urban	Total	Farm
Elko	12,011	6,298	5,713	1,644
Eureka	767	0	767	166
Humboldt	5,708	3,453	2,255	648
Lander	1,566	0	1,566	121
Pershing	3,199	0	3,199	435
Total	23,251	9,751	13,500	3,014
State	285,278	200,704	84,574	10,106

Source: U.S. Census of Population

Of the 23,251 individuals in the five basin counties, 9,880 were in the civilian labor force in 1960. About 96 percent (9,516) were employed, leaving only four percent unemployed. This was two percent less unemployed than the State average.

Only 1,587, or 17 percent of those employed, were employed in agriculture in the five basin counties. Agricultural employment comprised only four percent of workers employed in the State. About 32 percent of all agricultural employment in the State was located in the five basin counties. The following tabulation shows employment data in these five counties and the State for 1960:

Item	Civilian labor force	Employed	Percent unemployed	Agricultural employment 1/
Elko	5,001	4,805	4	792
Eureka	360	348	3	127
Humboldt	2,454	2,390	3	340
Lander	637	601	6	123
Pershing	1,428	1,372	4	205
Total	9,880	9,516	4 (ave.)	1,587
State	119,842	112,451	6 (ave.)	5,037

1/ Includes private wage and salary, government, self-employed, and unpaid family workers.

Source: U.S. Census of Population

Some farm and ranch operators are not fully employed on their units. Off-farm employment increases family income and provides a higher standard of living to many farm families. About 16 percent of the farm operators in the five basin counties worked off their farms in 1959. Sixty percent of these operators working off the farm had non-farm income that exceeded income from the sale of agricultural products. Almost 10 percent of the farm operators worked 100 or more days off the farm. Off-farm employment in the five basin counties and the State was as follows:

Item	All farm operators	Operators working: Total	Operators working: 100 or more days	With other income of family exceeding value of agricultural products sold
Elko	238	26	13	9
Eureka	40	13	4	2
Humboldt	129	19	16	13
Lander	22	3	1	2
Pershing	115	29	16	28
Total	544	90	50	54
State	2,354	502	269	322

Source: U.S. Census of Agriculture.

Median family income for all families in the five basin counties ranged from $5,153 in Lander County to $6,220 in Pershing County. All basin counties reporting had a median income for all families below that for the State.

Agricultural Income

The price-cost squeeze in the United States has decreased net income to agriculture in general, and Nevada ranchers in particular. In 1959 Nevada ranchers received a gross income of 58 million dollars, which netted 17.6 million dollars. By 1963 gross income had dropped to 49.2 million dollars; with increased costs and decreased prices, net return was only 4.2 million dollars. The following tabulation indicates the trend in gross and net income received by Nevada ranchers:

Item	1950	1955	1960	1961	1962	1963	1964
	Million dollars						
Crops and livestock sold	48.7	37.4	48.9	44.6	45.4	45.0	41.7
Value products consumed on farm	1.8	1.3	1.0	1.0	1.0	1.0	1/
Government payments	.2	.3	.9	.9	1.0	1.0	1.1
Rental value farm dwellings	1.9	2.6	2.1	2.1	2.3	2.2	1/
Gross farm income	52.6	41.6	52.9	48.7	49.7	49.2	1/
Farm production expenses	29.5	31.4	38.7	38.9	42.2	45.0	1/
Net farm income	23.1	10.2	14.2	9.7	7.5	4.2	1/
	Dollars						
Gross income per farm	15,932	13,863	20,348	19,462	20,692	21,399	20,844
	Percent						
Net as a portion of gross income	44	24	27	20	15	8	1/
	Numbers						
Number of farms	3,300	3,000	2,600	2,500	2,400	2,300	2,200

1/ Not available

Source: Statistical Reporting Service

This income was not divided evenly over the State. About 22 percent of the ranches (those in the five basin counties) received 45 percent ($26,231,382) of the gross income in the state for 1959.

In 1959, 93 percent of the gross sales from all farm products in the basin came from livestock and livestock products. This was almost entirely from sales of cattle and sheep. Only seven percent of the gross farm receipts were from crops. These crops were field crops other than vegetables, fruits and nuts. The amounts of income by county (and the five-county total) in 1959 from various sources were as follows:

Item	Elko	Eureka	Humboldt	Lander	Pershing
	Dollars				
All crops sold	305,407	15,457	378,942	190	1,137,618
Field crops	304,941	15,454	374,928	135	1,137,613
Other	466	3	4,014	55	5
All livestock and products	11,380,359	1,486,951	6,312,818	1,323,572	3,890,068
Dairy products	438	-----	3,192	-----	22,350
Poultry and products	5,946	980	6,537	999	3,010
Other livestock	11,373,975	1,485,971	6,303,089	1,322,573	3,864,708
All farm products sold	11,685,766	1,502,408	6,691,760	1,323,762	5,027,686

Source: U.S. Census of Agriculture.

A summary of income in 1959 in the five counties shows:

Item	Dollars	Percent of each	Percent of total
All crops sold	1,837,614	100.0	7
Field crops	1,833,071	99.8	
Other	4,543	.2	
All livestock and products	24,393,768	100.0	93
Dairy products	25,980	.1	
Poultry products	17,472	.1	
Other livestock	24,350,316	99.8	
All farm products sold	26,231,382		100

Source: U.S. Census of Agriculture

Farm and Ranch Characteristics

Livestock farms other than dairy and poultry were the major farm type in 1959. The livestock enterprises are based almost entirely on the production and sale of feeder cattle, some of which are fattened in Lovelock Valley each year. (See photograph 35.)

According to the Census of Agriculture, there were no dairy or poultry farms in 1959 in the five major counties of the basin. Only 16 farms were classified as field crop other than vegetable, fruit and nut farms. There were 17 general farms without a major enterprise, and 71 farms which were miscellaneous and unclassified. Many of the latter group were small noncommercial operations. The following tabulation shows farms by type for Nevada and the five basin counties in 1959:

Farm Type	Basin Counties						State total
	Elko	Eureka	Humboldt	Lander	Pershing	Total	
	Number						
Field crop farms other than vegetable, fruit and nut	--	--	9	--	7	16	62
Poultry farms	--	--	--	--	--	--	31
Dairy farms	--	--	--	--	--	--	159
Livestock ranches (income of 50% or more derived from sale of livestock or livestock products)	120	17	62	15	23	237	409
General farms and livestock ranches	189	37	89	22	87	424	1,361
Miscellaneous and unclassified farms	22	--	27	2	20	71	702
Totals	331	54	187	39	137	748	2,724

Source: U.S. Census of Agriculture.

Farm and ranch numbers in the basin are declining. In 1954 there were 576 units reported in the five counties, compared to 511 in 1959. While number of units in the five

Photograph 35. - Fattening feeder cattle, Lucky Land and Livestock Company Ranch, Lovelock Sub-Basin. Feeder cattle operations are becoming increasingly more important in Lovelock Valley each year.

counties decreased between these years, total land in farms and ranches increased from 5,301,668 acres in 1954 to 5,716,584 acres in 1959. Thus, average size of units increased. Average size of operation for the five counties of the basin (1944 to 1959 census years) was as follows:

		1944	1949	1954	1959
Elko	Elko	6,135	6,885	10,628	13,239
	Eureka	7,018	8,528	5,395	7,122
	Humboldt	1,983	4,762	7,770	8,043
	Lander	12,144	19,794	19,421	16,377
	Pershing	1,114	3,507	5,417	7,678
Five-county average		4,662	6,371	9,188	10,508
State		1,802	2,271	2,881	4,649

Source: U.S. Census of Agriculture.

From the 1959 irrigated land location map of Nevada a comparison can be made of the irrigated land in the basin as contrasted to that of the State. Total acres irrigated in each county, percent of irrigated land in the basin, and total irrigated acreage in the basin for 1959 were as follows:

	Total county acres irrigated 1/	Percent in basin 2/	Basin acres irrigated
Elko	101,593	49.0	49,780
Eureka	18,807	44.4	8,350
Humboldt	38,106	61.5	23,435
Lander	8,136	60.2	4,936
Pershing	33,361	100.0	33,361
Nye	23,292	26.5	6,166
Total	223,295	57.9	126,028
State	542,976	23.8	

1/ U.S. Census of Agriculture.

2/ Irrigated land location map, 1959.

Irrigated land in the basin accounted for about 24 percent of the total land irrigated in the State, and 58 percent of the six county total shown above. About 78 percent of the land irrigated in the basin was harvested in 1959.

Crop Production

In 1959 the total cropland harvested in the five counties amounted to 177,328 acres, and is broken down by counties as follows:

	All grain		All hay		Other	Total cropland
	Total	Wheat	Total	Alfalfa	crops	harvested
	---Acres---					
Elko	484	151	102,192	8,691	39	102,715
Eureka	55	11	9,202	2,742	26	9,283
Humboldt	8,275	7,918	20,780	7,661	1,010	30,065
Lander	0	0	5,812	2,808	7	5,819
Pershing	9,036	6,112	20,048	16,549	362	29,446
Totals	17,850	14,192	158,034	38,451	1,444	177,328
State	34,923	19,984	290,060	120,598	12,546	337,529
	---Percent---					
Percent State total	51	71	54	32	12	42

Source: U.S. Census of Agriculture

Of the 337,530 acres of cropland harvested in the State, 52 percent was located in the five basin counties in 1959. This relation was about the same as the proportion of livestock in the area.

Hay is the primary crop harvested in the basin, with alfalfa comprising about one-fourth the acreage harvested. The five basin counties harvested 54 percent of the hay acreage in the State in 1959. (See photograph 36.)

Photograph 36. - Hay harvest, Peterson Ranch, Lamoille Valley, in the Ruby Mountains Sub-Basin. SCS PHOTO --- 6-482-5

Over one-half of the grain harvested in Nevada was produced in the five basin counties in 1959. These counties were the primary wheat area in the State, producing 71 percent of the total crop. (See photograph 37.)

Crops grown in Humboldt and Pershing Counties were more diversified than in the other counties (see photograph 38). However, hay was the major crop, even in these counties.

Livestock Production

Beef cattle are the main livestock on basin ranches (see photograph 39). Sheep are second in importance, with milk cows, pigs, and poultry as minor livestock. In 1959 ranchers in these five counties owned about 56 percent of the cattle and calves and 47 percent of the sheep reported in the State. In 1959, the livestock on ranches in the five counties was as follows:

Item	Cattle and calves	Milk cows	Hogs and pigs	Sheep and lambs
		Head		
Elko	151,092	493	199	90,964
Eureka	17,046	58	73	23,540
Humboldt	72,046	214	216	16,577
Lander	21,403	41	99	11,524
Pershing	28,299	109	229	3,391
Total	299,961	915	816	145,996
State	431,022	13,624	10,360	311,848
		Percent		
Percent State total	56	7	8	47

Source: U.S. Census of Agriculture.

The calf crop in the basin varies widely, with yields ranging from 43 percent in the south-central area to 95 percent on some ranches in the northern areas, with an average of 77 percent for the basin. Average weaning weights of calves vary from a low of 250 pounds in the south-central area to a high of 450 pounds for northern areas. These weights depend upon date of birth, available forage, and hereditary growth potential.

The lamb crop in the basin ranges from 70 to 120 percent, and averages about 88 percent. Many of the lambs come off the range with sufficient finish to go directly to packers.

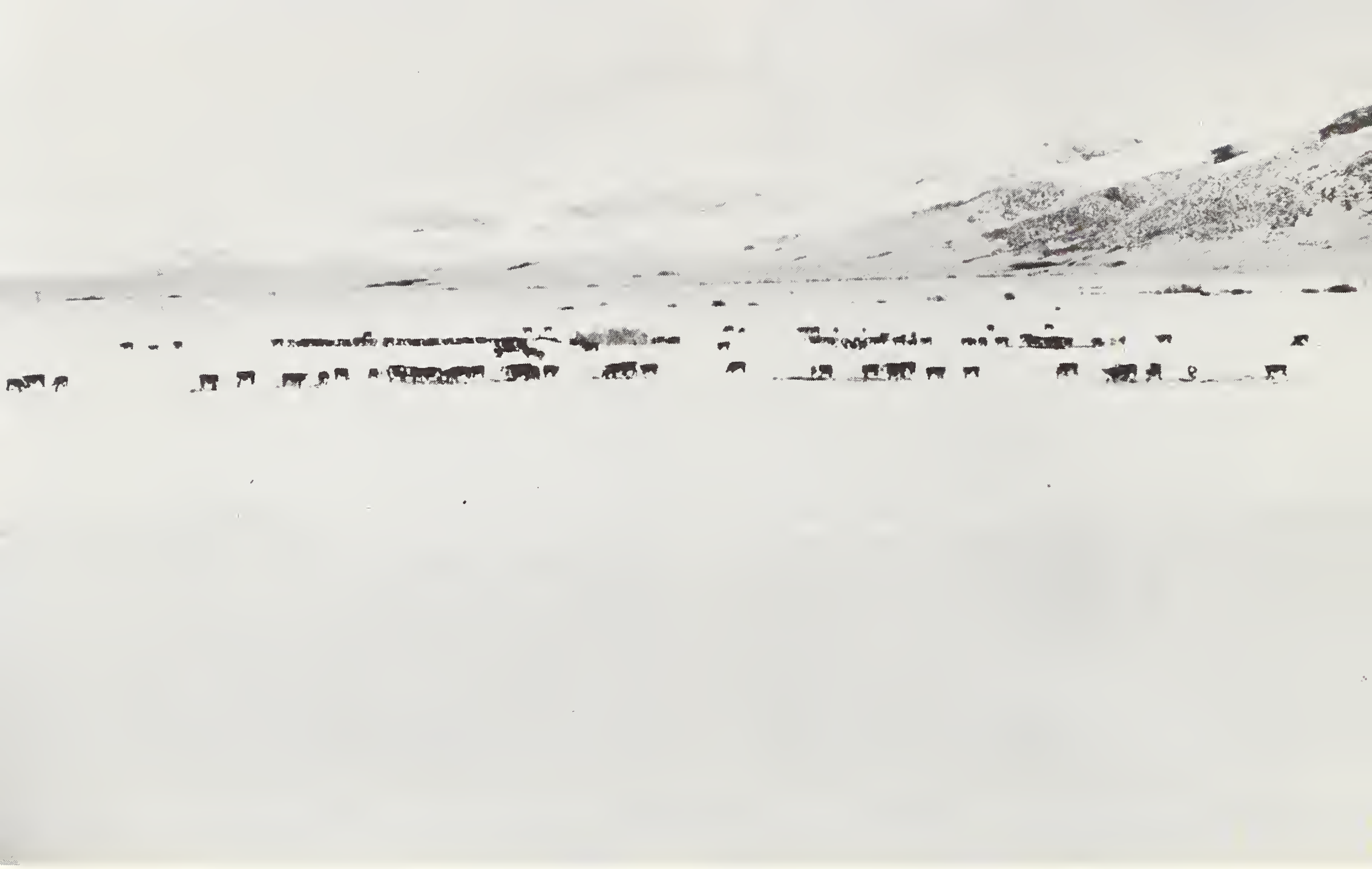
Federal lands provide most of the spring and summer feed for the breeding herds, both cattle and sheep. Of the total livestock feed required, the Federal and intermingled rangelands provide forage for approximately six months of the year. Some winter range for sheep is also available in the southern portion of the basin. The balance of feed is provided by two or more months private grazing on crop aftermath, adjacent dry and irrigated pasture, and three to four months on hay and concentrates (see photograph 40).

About 274,381 animal units (A.U.'s) were maintained in the five counties in 1959. Cattle and calves comprised about 90 percent of this total.

Photograph 37. - Wheat ready for harvest, Grass Valley, Sonoma Sub-Basin.
SCS PHOTO --- 6-409-1

Photograph 38. - Potato-harvesting. Grass Valley, in the Sonoma Sub-Basin.
SCS PHOTO --- 6-356-10

Photograph 39. - Beef cattle are the economic mainstay of most Humboldt Basin ranches. Cattle on crested wheatgrass seeding, Ruby Mountains Sub-Basin.
SCS PHOTO --- 6-765-8



Photograph 40. - Winter-feeding cattle, Lamoille Valley, Ruby Mountains Sub-Basin.
SCS PHOTO --- B-809-6

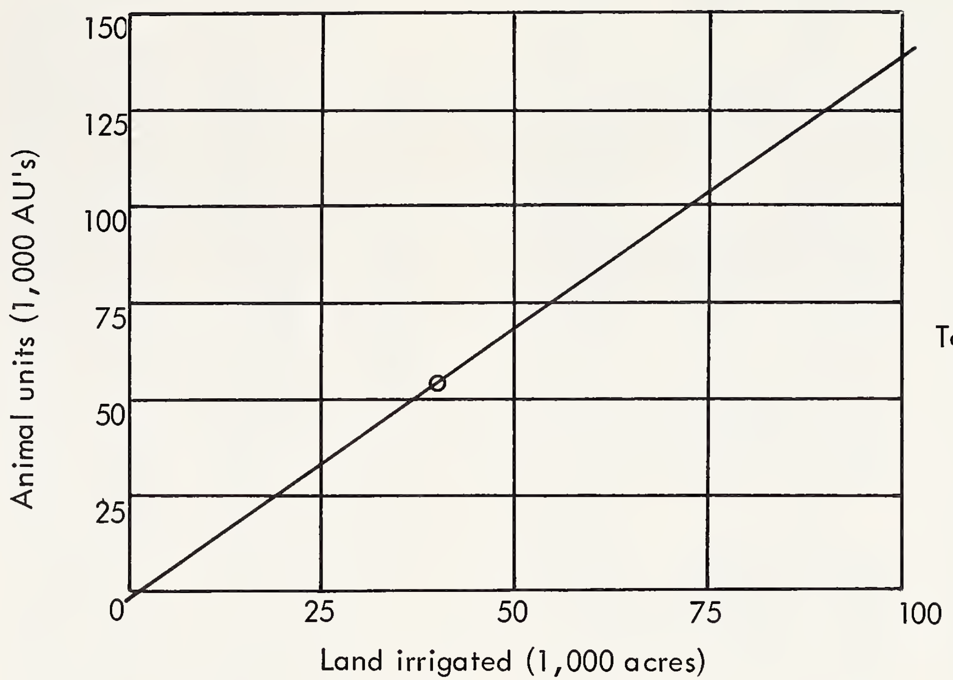
According to Field Party estimates based upon material from all available sources, 183,891 A.U.'s were maintained on basin ranches and adjoining ranges in 1959 (see figure 3). This would require about 1,103,346 animal unit months (A.U.M.'s) of public and intermingled private range, assuming six months of grazing. The remaining feed was harvested by livestock grazing on crop aftermath, adjacent dry and irrigated pasture, and harvested hay, to obtain a total of 2,206,692 A.U.M.'s of feed for basin livestock. Licenses and permits issued by the Bureau of Land Management and Forest Service for basin ranges in 1964 were estimated to be 774,000 A.U.M.'s. Some crossing of basin cattle out of the basin and nonbasin cattle into the basin occurred.

Livestock Marketing

Cattle are marketed from the basin in a seasonal pattern. Almost half the livestock sales take place during September, October, and November. The majority of the feeder livestock are sold to buyers at the ranch. Cows, bulls, and small lots of other classes of cattle are often sold at auction or to local buyers.

According to Barmettler's 1962 University of Nevada study, Destination of Nevada Cattle, there were 179,087 head of cattle and calves shipped from the basin in 1959. The major classes of cattle shipped were steers, 35 percent; heifers, 18 percent; calves, 19 percent; and cows, 18 percent. Steers and heifers shipped made up 58 percent of all cattle reported shipped from Nevada in 1959. Cattle shipments by class for five counties in the Humboldt Basin in 1959 were:

Figure 3. -- Animal units per 1,000 acres of land irrigated in five basin counties, 1959



	Animal Units	Land irrigated	Counties
	144,280	101,593	Elko
	18,345	18,807	Eureka
	61,012	38,106	Humboldt
	19,427	8,136	Lander
	31,317	33,361	Pershing
Total	274,381	200,003	5 counties

County	Steers	Heifers	Mixed heifers & steers	Calves	Cows	Other	Total
Elko	28,028	17,712	4,570	14,240	17,082	3,868	85,500
Eureka	3,021	1,055	119	2,234	2,806	312	9,547
Humboldt	9,572	4,592	1,756	11,325	5,046	2,584	34,875
Lander	3,624	851	146	2,887	2,743	1,127	11,378
Pershing	18,573	8,664	1,662	3,419	4,688	781	37,787
Total	62,818	32,874	8,253	34,105	32,365	8,672	179,087
	Percent						
Portion of total shipped	35	18	5	19	18	5	100

Specific destinations were reported for 139,692 head of cattle shipped in 1959; destinations for 39,395 head shipped were unreported. California packers and feeders received 46 percent of the cattle with known destinations, while 20 percent went to Idaho, eight percent to Nebraska, and 23 percent consisted of intrastate shipments. Other western States received three percent of the cattle shipped. Shipments from the five counties for 1959 are as follows:

County	California	Idaho	Nebraska	Nevada	Other	Total
	Number					
Elko	21,181	17,368	8,353	16,438	3,919	67,259
Eureka	4,031	886	445	2,076	312	8,750
Humboldt	14,302	8,131	1,958	3,926	349	28,666
Lander	4,494	1,185	391	814	196	7,080
Pershing	18,377	226	215	9,119	0	27,937
Total	63,385	27,796	11,362	32,373	4,776	139,692
	Percent					
Portion of total shipped	46	20	8	23	3	100

Transportation

Transportation facilities available to basin ranchers are generally adequate. Southern Pacific and Western Pacific, both interstate railroads, traverse the basin and provide daily schedules to the West Coast and eastern points. These railroads offer livestock transportation service, with loading facilities dispersed throughout the length of the basin. (See photograph 2.)

Transcontinental U.S. Highway 40 (Interstate 80) and U.S. Highway 50 link the basin with western and eastern points (see photograph 3). U.S. Highways 93 and 95 provide access to Idaho and Oregon to the north and Arizona and California to the south. Many Nevada highways serve outlying areas in the basin. During good weather, numerous other roads and truck trails provide access to most parts of the basin.

Trucks transported 82 percent of the cattle shipped from the five basin counties. About 16 percent of the cattle traveled by rail. Two percent of the shipments had no mode of transportation reported. Truck and rail transportation by county for 1959 was as follows:

County	Number	Truck	Rail	Not reported
	Number			
Elko	67,269	46,517	19,375	1,367
Eureka	8,750	7,691	1,059	-----
Humboldt	28,666	27,487	261	916
Lander	7,080	6,171	581	328
Pershing	27,937	26,821	903	213
Total	139,692	114,687	22,179	2,824
	Percent			
Portion	100	82.1	15.9	2.0

Several motor freight common carriers maintain terminals in Wells, Elko, Battle Mountain, Winnemucca, and Lovelock, and provide service to all parts of the nation. Some local carriers provide intrastate service. California and Idaho truck carriers also transport livestock from the basin.

The Nevada study previously cited indicates that in 1959 buyers furnished transportation in over 95 percent of the cases when sales were made at the ranch. This study shows that both buyers and sellers generally preferred highway carriers. Although rail service is provided by two major railroads, they do not generally provide services for bringing animals from outlying areas to railheads, nor are such services available at destinations for movement from railheads to final destinations.

Movements of livestock during September, October, and November exert considerable pressure on existing Nevada transport services. However, since the buyers provide most of the transportation for the movement of cattle, they employ many out-of-State trucking firms from the adjoining States of California and Idaho.

RECREATION AND WILDLIFE

Recreation Use

Development of the Humboldt Basin's recreation potential, except for big game hunting, bird hunting, and fishing, has been laggard. There has been little development of facilities for picnicking or overnight camping, other than those on national forest areas. Even on those lands, the potential for such development still remains largely untapped. Areas of scenic beauty in the central and eastern Nevada hinterlands, such as the Jarbidge, East Humboldt, Independence, Santa Rosa, and Toiyabe Ranges and the Ruby and Tuscarora Mountains, have remained largely unseen, unknown, and unused by sightseeing and relaxation-bent recreationists. (See photograph 41.)

Photograph 41. - Recreationists using the facilities of the improved campground at Angel Lake, in the East Humboldt Range. Humboldt National Forest, Ruby Mountain Sub-Basin. ADRIAN ATWATER PHOTO

This lack of development may be largely attributed to the remoteness and difficulty of access to this wild Humboldt Basin back country, as compared to the more readily accessible and available outdoor recreation areas in western Nevada and eastern California. As a result, the generally scanty public funds available in the past for recreation area development were, by and large, allocated to these heavy use areas to the westward.

However, as indicated in the Statewide recreation master plan recently completed (August 1965) by the Nevada Department of Conservation and Natural Resources, the outdoor recreation resources of western Nevada and eastern California have reached the saturation stage of crowding and overuse. The master plan indicates these acres must be relieved by a planned expansion into other sections of Nevada. The Humboldt Basin, by virtue of its geographical location in the State, and its as yet largely undeveloped recreation potential, offers a natural outlet for this excessive demand in western, and to some extent, southern Nevada.

Within the past two years the Bureau of Land Management, under its recent multiple use authorization from the Congress, has become increasingly active in the planning and development of recreation areas in the basin, as have several counties, municipalities, and at least one utility.

To date, there has been little development on privately owned lands, except for hunting and fishing camps, packer and guide services offered by a number of ranchers, principally in the vicinity of the Jarbidge Range and the East Humboldt and Ruby Mountains. This same type service is also offered, on a somewhat lesser scale, by a few ranchers adjacent to the Toiyabe Range.

Wildlife

Photograph 42. - Deer harvests such as this one of recent vintage were not possible when the white man first came to the Humboldt country. Modern, scientific big game management has built up deer herds to such an extent that the taking of excess numbers annually is now possible. Paradise Valley, Little Humboldt Sub-Basin. FIELD PARTY PHOTO

Big game species, such as mule deer and antelope, were not plentiful in the Humboldt Basin at the time of the coming of the white man (see photograph 42). Peter Skene Ogden, in his 1828-1829 journals, makes note of only one instance; the taking of three antelope, somewhere in the upper Humboldt Basin above Elko. The Sublette Party in 1831, according to Thompson & West, become so famished for meat while traveling along the Humboldt they were forced to eat the flesh of the beaver they caught.

Zenas Leonard, clerk for the 1833-1834 Bonneville-Walker fur party, emphasized in his journal the scarcity of any game larger than a rabbit along the entire course of the Humboldt, "except goats" (probably big horn sheep or antelope) which the party observed about September 12, 1833 in the East Humboldt-Ruby Mountains area. This, if the reference is to big horn sheep, is the first recorded observation of this big game species, once fairly plentiful in these upper Humboldt highlands.

During the period of westward migration, many of the journals kept by the emigrants record the scarcity of big game along the Humboldt, although one journalist, Madison Moorman, in 1850 noted the windrows of piled juniper and pinyon limbs and trunks in the vicinity of Hastings (Overland) pass across the Rubies. These windrows were piled by the Indians, according to Moorman, to aid in trapping deer, which were driven into them by the Shoshones, cornered, and killed.

If any further testimony were needed as to the lack of mammalian game species larger than the rodent family along the Humboldt, the state of the early Indian economy in eastern and central Nevada should furnish sufficient proof. The Shoshones there, often called "Diggers", "Bannocks", or "Shoshokos" by the early whites, subsisted on roots, pinyon nuts, insects, and lizards, with rabbits and ground squirrels furnishing the greater portion of the mammals they were able to kill.

In the 1870's and 1880's, the Humboldt Basin was filling up with miners and settlers, following the Humboldt silver strikes at Humboldt City, Star City, and Unionville in 1860-1861, and the Austin mining boom, beginning in 1862. This early influx of miners was, of course, swelled immeasurably by the construction of the Central Pacific Railroad, 1868-1869, and the development of such railroad towns or staging and freighting centers along the rail artery as Lovelock, Winnemucca, Battle Mountain, Carlin, Elko, and Wells.

About the only form of recreation available to these hard-working, hard-playing early Nevadans, outside the roistering bars, bordellos, and gambling halls in the primitive river towns and mining camps, consisted of hunting and fishing sorties along the

Humboldt and its tributaries, or into the surrounding mountains. Big game numbers at this time, although still not plentiful, seemed greater than in the 1850's and 1860's, according to Thompson & West in 1881.

However, by the late 1880's the baneful effects of unlicensed and uncontrolled hunting began to be felt on existing big game populations. By the turn of the century the bighorn sheep was practically an extinct species in its former haunts in the Ruby, East Humboldt and Toiyabe Ranges. The species was decimated by hunting, as well as by the ruination of its food supply through overgrazing by great numbers of transient sheep summering on the high mountain ranges during the 1880's, 1890's and early 1900's. The pronghorn (antelope) was despaired of at this time also; its days as a living species in Nevada and all over the west were thought by Seton, Hornaday and other naturalists of the time to be numbered.

Mule deer then, although not in as desperate straits as the two fore-named species, were nevertheless very scarce. One resident of Elko County recorded that in 1909 it took him and two companions three days of hard hunting in the Tuscarora Mountains to bag two deer, and at that they considered themselves lucky.

It was not until the establishment of the County Warden system and the sale of hunting licenses about 1908 that this downward slide into oblivion began to be arrested for big game species, as well as for such upland game birds as the sage grouse. However, these developments came too late for the big horn sheep in the Ruby Mountains and its habitats in the other mountain ranges of the upper Humboldt Basin. Fortunately, it managed to hold on in the Toiyabes, and at present even seems to be increasing its numbers there.

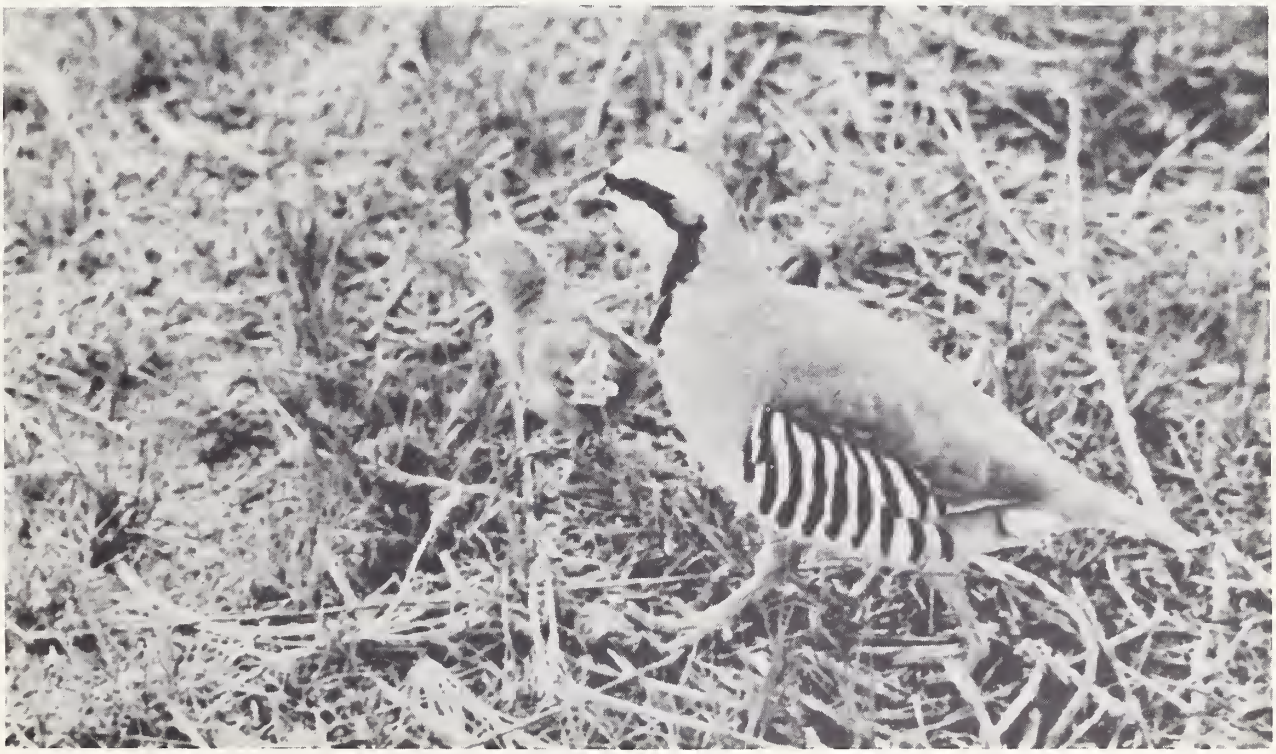
It was also too late for the sharp-tail grouse, called "prairie chicken" by the emigrants and early settlers. This upland bird was as much a victim of its changing habitat - the depletion of the perennial grasses necessary for its existence by livestock overuse from the late 1870's to the turn of the century - as by hunting pressures.

Following the establishment of controlled hunting (or complete protection as long as necessary, as in the case of the pronghorn) the regeneration of big game populations in the basin began, although numbers were still very low as late as the 1920's. By the late 1930's, however, use of range feed by deer had begun to play an increasingly significant role in the management of forage resources and watershed vegetal cover in the Humboldt Basin. Since 1948, when the present Nevada Fish and Game Commission was set up, and scientific methods of big game management instituted, the salient portion of the big game management program has been directed toward obtaining a deer harvest each year adequate enough to keep deer numbers in balance with their available food supply. (See photograph 43.)

The Nevada Fish and Game Commission's management program for game birds in the Humboldt Basin has been a vigorous one, and generally successful. The downward trend in sage grouse numbers has been reversed, and the gap left in bird populations by the decline of the sage grouse and the elimination of the sharp-tail grouse has been more than filled by the great success of the chukar partridge (introduced into the upper Humbolt Basin in 1949), and the valley quail (see photograph 44). A new non-native species, the Himalayan snow partridge, was introduced into the higher reaches of the Ruby Mountains in April 1963, but to date the success of this introduction is not known (see photograph 45).

Photograph 43. - Mule deer bucks congregated in the high country. Jarbidge Range, Humboldt National Forest, Mary's River Sub-Basin. GEORGE GRUELL, FOREST SERVICE PHOTO

Photograph 44. - The chukar partridge, since its introduction into the upper Humboldt Basin in 1949, has become the principal game bird species in the basin. An adult bird with her young. NEVADA FISH AND GAME COMMISSION PHOTO



Photograph 45. - Himalayan snow partridge, related to the chukar, but a much larger bird, is a recent (1963) introduction into the Ruby Mountains high country. Both roosters and hens are seen here. GENE CHRISTIANSON PHOTO

To further round out the selection of game bird species available to Nevada hunters, the commission has brought in small numbers of ruffed grouse from southeast Idaho. This species, which is not indigenous to the Humboldt Basin, was planted in the lower stream bottoms of a few of the Ruby Mountain west-facing drainages. These Ruby areas are quite similar in vegetal composition to the Idaho haunts of this bird species, and the transplanting now appears to have been successful.

In addition to this program of management and protection of the established non-native game bird species, the commission protects, manages, and investigates the life history requirements of the native bird species. These would include (besides the sage grouse) blue grouse, mourning dove, and various waterfowl.

While big game and game bird populations and their management in the Humboldt Basin continue generally to improve from all-time lows around the turn of the century, the story of fisheries management and development, for the basin as a whole, is not such a happy one.

In marked contrast to big game, the fisheries resource of the Humboldt Basin, when the first emigrant trains began rolling along the river in the 1840's, was excellent. The pioneers could always catch trout from the Humboldt or its tributaries, even if they found little game. At the time the Elko Reach was settled by whites, this portion of the Humboldt River was widely known for its trout fishing. The Elko Independent for June 30, 1869 noted that small boys were catching long strings of fine cutthroat trout along Maggie and Susie Creeks and stretches of the Humboldt River adjacent to Carlin.

Early descriptions of Pine Creek and Pine Valley (Elko Independent, 1869-1870 files) are in marked contrast to the present conditions along that stream, with its deeply gullied channel and wildly fluctuating stream regimen of increasingly alkaline, muddy water. An 1870 observer described Pine Valley as "a long grassy valley, with a clear, silvery stream of water running through the center". Another report that same year stated that Pine Creek was noted for its splendid trout fishing. As late as May 1913, the Eureka Sentinel noted many families from Eureka has recently returned from the Roberts Creek Mountains at the head of Pine Valley with great numbers of rainbow trout.

Reese River, which now furnishes trout fishing only at its headwaters or along its upper tributaries, in the period 1859-1895 furnished good angling along its main course as well as its tributaries, as far downstream as Reese River Canyon. Captain J. H. Simpson, when he crossed the Reese River west of present Austin on May 29, 1859, noted that trout weighing between two and three pounds were common in its waters. When trout populations during this 1859-1895 period did run low, they were periodically replenished from the Humboldt main stem during such wet-mantle flood years as 1884, 1886, and 1890, when Reese River flowed all the way to the main stream. As late as 1899, large trout were still being caught in Reese River and its tributaries near Austin. The Reese River Reville for June 19 of that year noted that an Austin boy had caught the largest cutthroat trout seen in that section for a long time, weighing over 12 pounds, and measuring over 30 inches in length.

In the light of these descriptions of past fishing glories, fishing conditions and fish populations for most of the Humboldt Basin have obviously worsened radically, especially during the last 65 years. Although large cutthroats continued to be taken along the upper Humboldt through and including the first quarter of this century, the effect of many years of deteriorating watershed conditions and water quality, uncontrolled wholesale predation of fish population, and primitive irrigation structures and practices, have practically eliminated trout fishing along the river itself and most of its lower and middle tributaries (see photograph 46). As noted, only the headwaters of such streams as upper Reese River, upper Mary's River, and the North and South Fork tributaries in the Independence and Ruby Mountains - including the glacial lakes of the Ruby and East Humboldt Ranges - continue to furnish good fishing in the Humboldt Basin (see photograph 47).

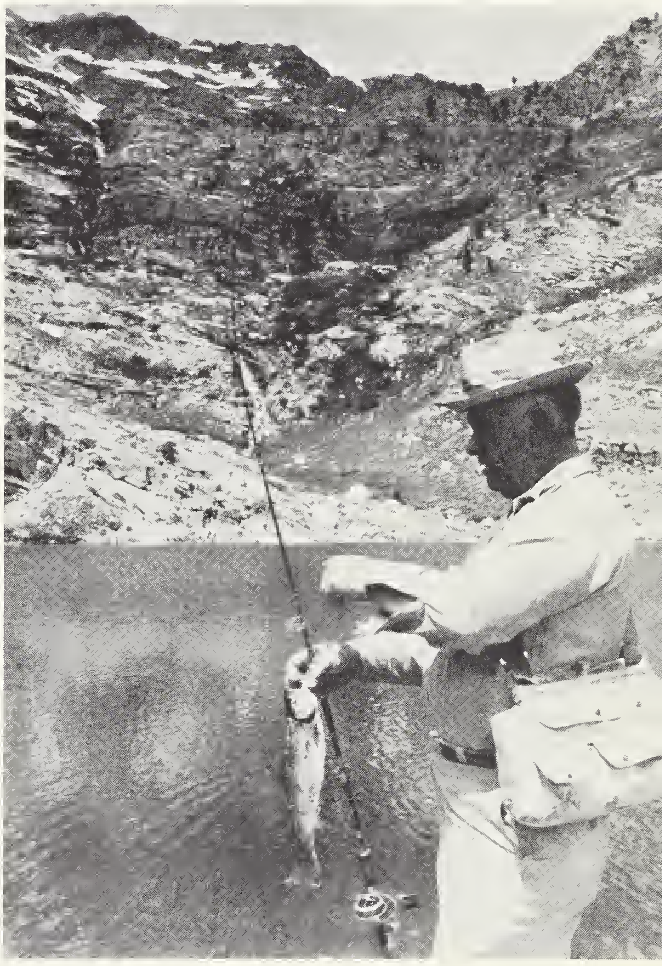
WATER AND RELATED LAND RESOURCE PROBLEMS and OPPORTUNITIES FOR DEVELOPMENT

Seasonal Water Supply

The shortage of water in the Humboldt Basin during the period when crop demands are highest creates a problem with respect to agricultural production. This is particularly true in the greater part of the basin above Rye Patch Reservoir. As previously noted, there are only a few regulatory structures in the basin where water can be stored for late irrigation use. As a result, crops grown are limited to those which can tolerate wide extremes in water use, and crop yields are below the potential for the area.

Problems involved when irrigation water is available for only one or two months during the start of the growing season can be solved more satisfactorily by developing additional storage, or supplemental water from ground water storage. The Field Party found at least 12 dam sites when investigating the feasibility of watershed protection and flood prevention projects in the Humboldt Basin. Preliminary investigation indicated that these sites have a potential for development under the provisions of Public Law 566. In addition to the authorized Corps of Engineers projects on the South and North Forks of the

Photograph 46. - *Trout fishing in most of the Humboldt Basin has deteriorated markedly over the past 90 years, or even the past 30. Earl Frantzen of Elko with his fine catch of cutthroat trout, Willow Creek Reservoir, Battle Mountain Sub-Basin, in the 1930's.* EARL FRANTZEN PHOTO



Photograph 47. - *Because of the Nevada Fish and Game Commission's vigorous fish-stocking program, fishing in the higher lakes and streams in the upper Humboldt Basin is generally improving. Angel Lake, Humboldt National Forest, in the Ruby Mountains Sub-Basin.* ADRIAN ATWATER PHOTO

Humboldt River and on Mary's River there may be other sites which could also be developed to store irrigation water.

When storage or water development is not practical, there are a number of improvements to cropland and in water management which would be helpful in increasing crop yields and conserving water. They include the leveling or smoothing of fields to permit a more uniform application of water, planting of crops that will produce the greatest yield per unit of water applied, and irrigating each field only to the extent necessary to fill the soil within the root zone to field capacity. In addition to the water supply needed for crop growth, it is necessary to apply excess water in some locations during the first irrigation for leaching of salts.

Problems in water management are more serious in drought years, and efficient use of water becomes even more essential during these periods. A few recommendations, other than those mentioned previously, which would help stretch a short water supply include: (1) irrigate only those fields having the better soils, which produce the highest yields, and are closest to the water source; (2) keep all ditches and laterals clean; (3) construct new or make necessary repairs to old structures, for better control of water; (4) avoid spreading small quantities of water over large areas of land; and (5) irrigate only when the soil becomes dry and crumbly, or the plants show early stages of wilting.

Technical assistance in planning and solving agricultural problems is available through the local soil conservation districts and the County Extension Agent.

Irrigation Structures

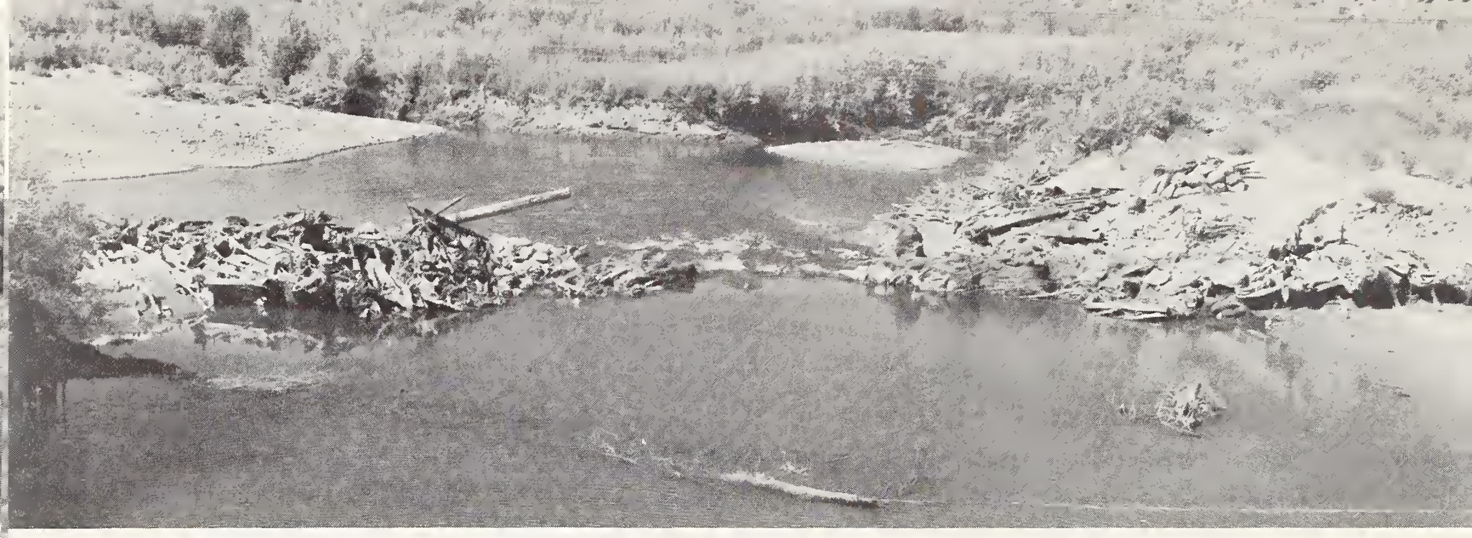
A major part of the flooding on bottomlands is caused by irrigation diversions constructed in stream channels which have openings too small to pass normal flows, or which have no means of controlling flow (tight dams). Floodplain lands are inundated whenever the stream flow exceeds the capacity of the control gates or dam openings. Although these structures are maintained as part of a low-cost method of irrigation, during periods of high flow the flooding inflicts damage to roads, bridges, farm buildings, stacked livestock feed, and in some instances, reduces the capacity of the stream channel. (See photograph 48.)

Conditions can be improved by developing storage for flood flows, and constructing properly designed diversions in all streams. In areas where cropland has been leveled and irrigation systems have been improved, the control of water is more positive (see photograph 49). There is a need, however, for additional ditch lining to prevent seepage loss, concrete drops in ditches to stop cutting, turnouts to reduce erosion at the heads of fields, and water-measuring structures to help determine the quantity of water being applied to a field (see photographs 31 and 50).

Use of Water

An estimated 47 percent of the water in the Humboldt Basin, both surface and subsurface, is consumptively used by irrigated crops, 38 percent by range phreatophytes, and 15 percent by evaporation by reservoirs and other water surfaces, (see Water Use).

Efficient use of water can be defined in many ways. For the purpose of this report, on-the-farm irrigation efficiency is defined as the amount of water required to bring the soil in the root zone to field capacity, divided by the amount of water applied. Using



Photograph 48. - A typical 'tight dam' diversion installation in the Humboldt River. Near Ryndon, in the Elko Reach. SCS PHOTO --- 6-773-2

Photograph 49. - Land-leveling and the installation of sprinkler irrigation facilitate a more positive control of water. Battle Mountain Sub-Basin. SCS PHOTO --- 6-605-8

Photograph 50. - Lining an irrigation ditch to prevent seepage loss. Dunphy Ranch, Battle Mountain Sub-Basin. SCS PHOTO --- 6-408-9

this definition, the irrigation efficiency obtained from the semi-controlled wild flooding method common to the basin is quite low; it is estimated to be 20 percent or less. In most cases the water is applied to the fields in large quantities, and is held there for a longer period of time than needed to satisfy soil requirements. This is not to imply that all the excess water is wasted; it does create an environment, however, for less desirable plant growth, and retards the growth of the better hay and forage species. As a result, lower yields are obtained.

Border, furrow, and sprinkler methods of irrigation, where applicable, offer a better opportunity for higher water use efficiency (see photographs 51 and 52). Irrigation efficiencies obtained in the Humboldt Basin using these methods of application vary widely, depending upon management. Irrigation evaluations made over several years by the U.S. Department of Agriculture indicate a range in efficiency from 25 to 70 percent for these methods.

Nonbeneficial phreatophytes such as greasewood, rubber rabbitbrush and saltgrass, among others, use an estimated 196,000 acre-feet of water annually, which is more than one-fourth of the total water use (736,000 acre-feet), or 69 percent of the total range phreatophytic use. About one-half of this nonbeneficial use is along the main stem of the Humboldt. (See table 3.)

Black greasewood comprises the greatest acreage of these water-wasting plants, and consequently uses the greatest quantity of water. This plant is relatively easy to control; however, without irrigation, replacement vegetation for ground cover is difficult if not impossible to establish, particularly on soils with high sodium concentrations. Rabbitbrush and saltgrass, on the other hand, are more difficult to control, but replacement vegetation for these plants is easier to establish.

In places along the Humboldt, dams and dikes for water-spreading have been placed across old channels and sloughs (see photograph 48). This practice creates a high-water table that lasts for a longer than normal period of time, and blocks the return of excess irrigation water to the river. As a result, more water is lost by evaporation, and less desirable plant growth is encouraged, which usually results in lower hay and forage yields. In addition, the obstructed meander channels and sloughs afford an opportunity for an undesirable increase in salt accumulation through evaporation of the ponded water, particularly in the middle and lower reaches of the Humboldt Basin.

Use of water in Lovelock Valley is, in general, excessive with relation to plant needs. Some excess water is required for leaching in order to maintain a favorable salt balance; however, an average of about 15 percent in excess of plant needs should be adequate to handle this problem. Annual allotments of water in the valley are based on predicted annual inflow and storage in Rye Patch Dam, not to exceed three acre-feet per acre, plus transportation losses. This distribution, however, is based on the total acreage with water rights, and not on the acreage to be irrigated in any particular year. Because of the greater acreage with water rights than that irrigated each year, considerably more water is applied to some of the land than is indicated by the annual allotments.

Opportunities for improving the use of water are closely related to the previous discussion entitled Seasonal Water Supply; the improvements recommended there would apply to both problems.

Nonbeneficial use of water is a subject with which all resource agencies as well as water users are concerned. The State Engineer is empowered to correct misuse of water

Photograph 51. - *Land leveling and border irrigation insure uniform application of irrigation water. Godchaux Ranch, Paradise Valley, in the Little Humboldt Sub-Basin.*

SCS PHOTO --- 6-502-6

Photograph 52. - *Sprinkler irrigation, Tomera Ranch, in the Elko Reach.*

SCS PHOTO --- 6-605-10

by the public; however, the problem of nonbeneficial use of phreatophytic (water-wasting) plants will need to be solved by other means. The use of water by these plants is estimated to be 196,000 acre-feet; 97,000 from along the floodplain of the Humboldt River and 99,000 from tributary drainages. The quantity of water that might be salvaged by the control of phreatophytes is difficult to determine. In order to do so, it would be necessary to clearly define the term nonbeneficial. Plants which might be considered relatively worthless for livestock use, such as willow and wildrose, may have definite value for soil cover and soil binding, and for wildlife and livestock protection. (See photograph 53.)

If it is assumed desirable to control phreatophytes for the purpose of using the salvaged water to surface-irrigate improved forage species, then the plants to be controlled would probably be limited to such species as tamarisk, cottonwood, and willow. If 100 percent control of these plants could be achieved, and wildrye grown in their stead, about 20,000 acre-feet of water would be made available for other purposes.

Other low-value phreatophytes are using approximately the same quantity of water, if not less, than would be required to grow more desirable forage. There is a large acreage in the Humboldt Basin where replacement vegetation can be established in place of the low-value plants, and thereby put the water these plants consume to beneficial use. The benefits would probably be measured in pounds of forage produced, rather than acre-feet of water saved.

There are large areas where, under existing natural conditions, greasewood is the only species which will tolerate extreme soil salinity. On such sites as this it would be impractical, if not impossible, to establish a cover which would have greater value from the soil protection standpoint than greasewood, if the greasewood were removed.

Photograph 53. - The willow-lined, serpentine channels of the Humboldt River about 8 miles west of Elko, in the Elko Reach. FIELD PARTY PHOTO --- 6-694-1

There have been several suggestions made for improving the use of water in the Humboldt Basin, and along the floodplain of the Humboldt River in particular. One recommendation involves the construction of highline canals on each side of the Humboldt River. This would require a diversion at Deeth and at the mouth of each canyon or narrows along the stream. Cropland would be irrigated from these canals, with the river channel acting as a drain outlet. During periods of high flow, the canals would serve to relieve the inundation along the floodplain. Engineering details of such a plan have never been developed. An overall design would include: (1) distribution ditches and laterals, to convey water to fields; (2) canal and ditch lining, to prevent excess seepage loss; (3) a system of drains, to prevent the development of a high water table; (4) clearing the river channel of all obstructions; and (5) leveling fields, so that an even application of water would be possible.

Other suggested improvements of general applicability include the following:

1. Consolidation of canals and ditches in locations where independent systems are closely paralleling and sometimes cross. This condition exists in the upper Humboldt Basin, (in Starr Valley and Lamoille), as well as Lovelock Valley in the lower basin.

2. Removal of tight dams (uncontrolled diversions). The replacement of these obstructions by a type of diversion that can be controlled would permit greater efficiency in water use as well as increasing the capacity of the river channel and reducing extensive flooding at these locations. This improvement would also reduce the chance of illegal use of water.

Soils

Accelerated erosion of soils by water, wind, and to some extent by ice, is active in the Humboldt Basin.

Sheet erosion by water is especially critical on the upland soils where rainfall is greater, slopes steeper, and vegetal cover too sparse to absorb rainfall impact and decrease runoff velocity. Concentrated runoff from uplands has resulted in the formation of gullies, which have become entrenched in many valleys and narrow stream bottoms throughout the basin (see photograph 54). Gullies headcutting into deep meadow soils have caused the drainage and desiccation of many of these valuable forage-producing areas (see photograph 55).

Accelerated erosion of upland soils has resulted in sediment damage to irrigation structures and agricultural land at many locations in the Humboldt Basin. Sediment damage is especially critical in such drainages as Mary's River, North Fork, Pine Valley, Maggie Creek, Little Humboldt, and Reese River, and in local areas along the Humboldt main stem.

Wind erosion, both removal and deposition, is widespread on soils at lower elevations throughout the basin. It is a major problem in that portion of the basin below Palisade, in areas having soils with sand, loamy sand, sandy loam, very fine sandy loam, and silt loam surface textures. Along the lower reaches of the Humboldt River, from near Winnemucca to Lovelock Valley, the rather severe effect of wind erosion is evidenced by relatively large areas of duneland on terraces and alluvial fans adjacent to the floodplain of the river. (See photograph 56.)

Photograph 54. - Heavily eroded and incised stream channel, upper Susie Creek, Maggie Creek Sub-Basin. SCS PHOTO --- 6-922-2

Photograph 55. - This headcut of the deep Pine Creek gulley at the lower end of Pine Valley continues to eat away unhindered at the Pine Creek bottomlands. Pine Valley Sub-Basin. SCS PHOTO --- 6-673-2

Photograph 56. - Sand dunes near the junction of the Little Humboldt Channel with the Humboldt River above Winnemucca. Little Humboldt Sub-Basin, looking easterly toward the Osgood Range. FIELD PARTY PHOTO --- 6-566-6

Reversal of the trend in erosion within the Humboldt Basin will need to give consideration to improvement of the vegetal cover, and to structural measures designed to control gullying, meadow desiccation, and sediment damage. Such a program will involve, in addition to structural measures, practices concerned with restoration, protection, and management of watershed lands, such as fire protection, revegetation, and improved timber and range management, among others.

The hydrologic characteristics of the Humboldt Basin are such that the majority of bottomlands and stream floodplain soils are subject to overflow during the spring-early summer runoff period. Lack of channels or inadequate channel capacity is primarily responsible for this problem. It is further aggravated by numerous "tight dams" installed to divert water for irrigation. The overflow problem severely restricts choice of crops, and the larger portion of the irrigated soils is consequently devoted to the production of rather low-quality and low-yielding native meadow hay and pasture. Overflow also contributes considerably to high water table conditions, and to loss of water by evaporation, as well as to a higher consumptive use by nonbeneficial phreatophytes. Long-term objectives for resolving the overflow problem are primarily concerned with water control. Upstream flood control reservoirs, channel improvement, and diversion structures designed to divert manageable quantities of water are essential considerations in realizing water control.

Photograph 57. - Digging a deep drain by dragline, lower Lovelock Valley; Lovelock Sub-Basin. SCS PHOTO --- 6-685-12

Overflow and ground water recharge to the water table have created an inherent condition of poorly or very poorly drained soils along stream floodplains and bottomlands. The water table in these soils is cyclic, rising in the spring and early summer months to within a few feet of the surface, and dropping to lower levels in the late summer and fall. In Lovelock Valley, excess irrigation water and canal losses have aggravated cyclic high water table levels.

Salinization and high exchangeable sodium in soils are widespread problems on the bottomlands and floodplains, and are directly related to the occurrence of high water tables and poor drainage. Soils subject to overflow or flooded annually for irrigation tend to contain less salt and exchangeable sodium, because of annual leaching. Soils not subject to overflow or only intermittently irrigated have accumulated high concentrations of salts. Since drainage is essential for leaching and removal of excessive salt concentrations, salt reduction in a large portion of the irrigated soils will continue to be a difficult problem, until such time as the overflow can be resolved, and adequate channel capacity is provided for drainage outlets. Under present conditions, irrigated soils should be used and managed to minimize the salt problem to whatever extent is feasible. Such practices as irrigation system improvement, land smoothing and leveling, use of salt-tolerant crops, and annual leaching treatments are essential in this connection.

The salt and drainage problem in Lovelock Valley has been partially corrected by installation of deep drains (see photograph 57). This became essential following construction of Rye Patch Reservoir, and the change from a short water supply to a season-long water supply, which created intensive irrigated land development. As a result, a more persistent and widespread high water table developed, causing an unfavorable salt balance in the soil. Further improvements are possible in Lovelock Valley through construction of additional drainage facilities, control of canal and ditch seepage, and improved irrigation water management.

Flood Control

Each flood period in the Humboldt Basin since the coming of the white man has contributed to channel erosion, sediment deposition, and extensive flooding along the Humboldt River and tributary streams. Of particular note were the floods of 1884, 1890, 1910, 1917, 1942, 1943, 1952, and 1962 (see photographs 58 through 63).

From 1870 to the present, there have been 22 years in which varying amounts of destruction have occurred; an average of one flood in every four years. This average has little meaning, however, as there have been two long periods, 15 and 16 years each, in the 95 years when no flooding took place. There were also two three-year periods when flooding occurred each year.

Active cutting in varying degrees can be found on most of the water courses in the basin. Clear, Pine, Rock, Maggie, Susie, and Rockhill Creeks, and Reese River, among many others, are in a deteriorated condition. Former ryegrass meadowlands throughout the basin have been drained by deep gullying, and presently support only rubber rabbitbrush, greasewood, or sagebrush.

Torrential summer rainstorms, often resulting in dry-mantle flooding, are common throughout the Humboldt Basin. These storms are usually confined to the stream sources on the higher watersheds, although they sometimes cause severe, but usually localized, downstream damage. Sediment resulting from sheet and gully erosion produced by this type of

Photograph 58. - The flood-swollen Humboldt River and the ruins of the Ninth Street Bridge, Elko, 1910. MILO TABER PHOTO

Photograph 59. - At Palisade the river swamped the Eureka & Palisade railroad yards, the south section of the town, and washed out the recently completed Southern Pacific railroad bridge, among other damages, 1910. MILO TABER PHOTO

Photograph 60. - In Winnemucca, the waters of the Humboldt River rolled over the floor of the Bridge Street Bridge, then the town's arterial connection with Paradise Valley, Quinn River, Oregon and Idaho points. The bridge was so weakened it was afterward completely rebuilt, 1910. BUCKINGHAM PHOTO COURTESY NEVADA HISTORICAL SOCIETY

Photograph 61. - The 1943 wet-mantle flood at Elko. Looking easterly toward the submerged Western Pacific railroad yards. MILO TABER PHOTO

Photograph 62. - In the spring of 1952 the flooded Humboldt River bottomlands near the confluence of the South Fork, a few miles west of Elko, appeared to be a willow-studded lake. SCS PHOTO --- 6-149-1

Photograph 63. - The February 1962 wet-mantle flood on the Humboldt River. Flooded meadows of the Horseshoe Ranch, near Beowawe, looking west. SCS PHOTO -- 6-659-7

storm is deposited mostly on fans at the mouths of canyons and along the floodplains in the valley bottoms.

Investigations made following some of the flood periods, both winter snowmelt and summer flash-flooding, have revealed extensive damage from sediment deposition to meadows along the Humboldt and its tributaries. Damage from sedimentation has varied from reduced yields on some fields to complete loss of meadow grasses on others. In addition, field ditches were silted full, and water control structures were covered.

Floodwaters have caused destruction throughout the basin, varying from loss of human life to reduced yields from hay meadows. Other reported damages from past floods include livestock drowning, destruction of farm buildings, fences, and spoilage of stacked hay.

Opportunities for the alleviation or elimination of flood damages are directly related to improvement in range and watershed conditions, as well as water control by large and small retarding reservoirs. These opportunities are more fully discussed in the sections concerned with range and watershed lands and water use. In addition, the Field Party found 20 watersheds within the Humboldt Basin where improvements might be installed with assistance, under the provisions of Public Law 566. Most of these projects would include some provisions for flood control.

Range and Watershed Conditions

Present Range Conditions

The total usable annual range forage now being produced in the Humboldt Basin is approximately 1,400,000,000 pounds (see table 4).

Approximately 80 percent of the basin is in the low forage production class, 15 percent in the medium, and only five percent in the fairly high. The greater percentage of land in the fairly high forage production class is located in the fenced bottomlands or seeded areas. Acreages of fairly high forage production are also found as relict areas on inaccessible or poorly watered portions of the public domain, on some privately owned ranges, or on the national forest lands, most of which have been under some form of regulated range management for 60 years (see photographs 64 and 65).

The Present Contrasted With the Past

On much of the present acreage in the saline bottomlands, characterized by continuous heavy livestock use and the lack of a suitable range management program, rubber rabbitbrush and black greasewood have invaded these former grassland sites, following thinning of the grass cover and the resultant gullying and meadow desiccation (see photograph 66). This deterioration is more apparent when present vegetal cover is compared with that the explorers, emigrants, and early settlers found from 80 to 100 years ago (see photograph 67). To illustrate the contrast between pristine vegetal species and conditions recorded by early observers in the Humboldt Basin and present species cover and conditions on the same areas, many early newspapers, pioneer journals, and descriptions by early explorers and settlers have been reviewed, and pertinent material abstracted for use here.

Table 4. -- Present and potential usable annual forage plant production by class and sub-basin, Humboldt River Basin 1/

Sub-Basin	Forage production classes, in 1,000-pound units							
	Present production classes				Potential production classes			
	Fairly high	Medium	Low	Total	Fairly high	Medium	Low	Total
Little Humboldt	33,555	85,897	70,758	190,210	314,952	101,124	12,469	428,545
Pine Valley	11,045	20,767	41,597	73,409	145,444	73,729	5,830	225,003
Ruby Mountains	57,577	54,887	58,163	170,627	249,587	84,482	9,755	388,824
North Fork	6,857	32,580	50,982	90,419	176,252	68,410	7,772	252,434
Mary's River	22,922	51,089	55,422	129,433	184,865	69,570	6,354	260,789
Maggie Creek	8,026	35,547	17,924	63,497	110,251	34,390	1,619	146,260
Elko Reach	1,157	17,141	21,197	39,495	83,992	29,534	1,686	115,212
Battle Mountain	138,455	104,563	102,237	345,255	326,372	213,087	33,048	572,507
Reese River	4,352	21,468	142,761	168,581	638,967	116,030	6,331	761,328
Sonoma	3,890	12,487	54,312	70,689	111,774	99,807	8,817	220,398
Lovelock	3,360	6,084	52,963	62,407	57,853	81,704	16,796	156,353
Total	291,196	442,510	668,316	1,404,022	2,445,309	971,867	110,477	3,527,653

Source: Humboldt River Basin Field Party.

1/ Midpoint of each forage production class for each vegetal site.

Photograph 64. - The 15,000-acre St. John Fields range, on the west slope of the Tuscarora Range in the Battle Mountain Sub-Basin, is one of the scattered examples of largely privately owned range lands in the Humboldt Basin which have maintained a fair semblance of their pristine cover. Here are yet to be found such desirable grass species as Idaho Fescue, Nevada bluegrass, Hesperochloa, and bluebunch wheatgrass, which have largely disappeared from adjacent private and public domain ranges.

FIELD PARTY PHOTO --- 6-922-7

Photograph 65. - The effects of 60 years (1906-1966) of regulated range management on the Humboldt National Forest are strikingly evident in the thick cover of bluebunch wheatgrass, Idaho Fescue, Nevada bluegrass, and Hesperochloa seen here. Head of California Creek, Independence Range, North Fork Sub-Basin. FIELD PARTY PHOTO --- 6-698-5

Photograph 66. - Old Elko County cattleman George Banks standing in 1953 on the lip of the eroded channel of Susie Creek, which in his boyhood was a clear perennial stream, with no erosion problem. Maggie Creek Sub-Basin. SCS PHOTO --- 6-182-5

Photograph 67. - Saline bottomland meadow on the TS range, Maggie Creek, in the Maggie Creek Sub-Basin. This site has been returned to a semblance of its pristine condition by selective brush spraying and proper livestock use, which encouraged the remnant understory of ryegrass and other perennial grasses to thicken and fill in.
FIELD PARTY PHOTO --- 6-922-4

A case in point is on upper Huntington Creek, west of the Ruby Mountains, which now runs intermittently in a deeply incised gully through a bottomland predominantly covered by rabbitbrush, with little or no perennial grass understory. On August 10, 1850, Madison Moorman recorded the following about this area in his journal:

> Just at dusk we stopped and encamped on a little clear rivulet, a tributary of the South Fork of St. Mary River or Humboldt River, coursing its way to the north through a fertile little valley well set with grass.

The journal of Edwin Bryant in 1846 noted the excellent stand of grass on the saline bottomlands in the vicinity of lower Secret Creek. He wrote:

> After wandering about for some time in compliance with the various opinions of the party, I determined to pursue a course due West, until we struck the river, and at sunset we encamped in the valley of the stream down which we had descended, in a bottom with most luxuriant and nutritous grass.

George Banks, pioneer Elko County cattleman, reminiscing in 1953 while inspecting the deeply gullied, deteriorated Saline Bottomland site at the head of Susie Creek, had this to say:

> This gully was not here when I was a boy (late 1870's-early 1880's). The sagebrush and rabbitbrush along the bottom used to be a meadow. Water ran on top of the ground, where the grasses used it and in turn held the soil in place. (See photograph 66.)

Many of the other range sites are also seriously deteriorated and depleted. This is substantiated by the fact that approximately 80 percent of the big sagebrush-grass vegetal site is in the low forage production class, with only 16 percent being in the medium and five percent in the fairly high forage production classes (see photograph 68).

Again, early diaries and journals furnish a graphic study in contrasts by depicting the pristine range and watershed cover conditions for this site. As an example, in 1846 James Clyman, traveling from California to the East, rode horseback across Emigrant Pass on May 19 of that year. He recorded this:

> About half way across these hills in (sic) several springs of cool water (upper and lower Emigrant Springs at Primeaux Station). Crossed over and encamped on tolerable good grass for the season.

That same year, James Mathers crossed the pass in September from east to west, and wrote as follows:

> Went through pass (Carlin Canyon), across the valley (Maggie and Susie Creeks or Carlin) and eight miles onto a high mountain (Emigrant Pass), and encamped by springs of very good water and grass (Emigrant Springs).

Photograph 68. - Big sagebrush-grass vegetal site in the low forage production class, North Fork Sub-Basin, northwest of the Devil's Gate Ranch. Note the expanse of bare soil, the hummocked and pedestaled plants, the lack of perennial grass understory, and the presence of low Douglas rabbitbrush and other undesirable browse and forb species.

FIELD PARTY PHOTO --- 6-703-5

Further evidence of what the present big sagebrush-grass range was like prior to its long period of generally heavy livestock use by the white man is furnished by Sam Furniss, who came to Elko in 1881 to be a cowboy. He wrote:

> The range was flowering and beautiful, and there was waving grass in all directions, from town. It sustained outfits running as many as 20,000 head. . . Grass was so thick and high that the cattle first reaching it were lost to sight.

Captain J. H. Simpson, exploring in 1859 for a military route across central Nevada, recorded these comments in his journal concerning the vegetal cover in the Toiyabe Range a few miles north of present Austin, Nevada:

> May 28, 1859 . . . Leave valley (Simpson Park) . . . and strike west for Simpson Pass, which we reach by a very easy ascent in 4.7 miles. Altitude above sea 7104 feet. The grass in the pass very abundant and of the finest character. This fine mountain bunch grass fattens and strengthens our animals like oats.

Captain Simpson could only have been talking about Idaho fescue or bluebunch wheatgrass in this last reference.

When he camped on Reese River itself, a few miles west of Austin, Captain Simpson had this to say about the grass cover on the Saline Bottomlands site there:

> The grass along it is luxuriant, but in many places alkaline. It is best and very abundant farther up the stream and extends as far as the eye can see . . . . Soil argillaceous and covered with the wild sage and greasewood. It is quite well watered, and several streams well grassed can be seen tending to it from the west slopes of the Pe-eneoch range (Toiyabe Range).

Deteriorating Range and Watershed Vegetal Cover in the Basin

Over most of the big sagebrush range area the better forage species, such as bluebunch wheatgrass, Thurber needlegrass, Idaho fescue, and Nevada bluegrass, have largely been replaced by such less valuable or inferior forage species as Sandberg bluegrass, cheatgrass, lupine, balsamroot, big sagebrush, desert peach, and low Douglas rabbitbrush. In some areas, low Douglas rabbitbrush has increased in density at a rapid rate following fire. In other localities where livestock use is or has been heavy, its presence is also very pronounced.

According to George Banks and other observers of the Humboldt Basin scene in the 1870's and 1880's, there was much more perennial grass at that time on the Upland Benches and Terraces and the Intermediate Mountain Slopes sites, and considerably less big sagebrush. (See Vegetal Conditions in the sub-basin report series, and photograph 64.)

The Shadscale-Bud Sagebrush vegetal site has only about four percent of its forage above the low forage production class. This area is the most accessible of all the vegetal sites to livestock, and undoubtedly has received the most extensive use, although in some locations a lack of stockwater limits the time and extent of use (see photograph 19).

The meadow grasses-forbs-sedges in the Semi-Wet Meadows vegetal site have a greater percentage above the low forage production class than any vegetal site in the Humboldt Basin. This undoubtedly is because the site is always found on the higher-quality moist soils of the river bottomlands, is usually fenced, and is being used under some type of range management program. Another factor accounting for the generally better range condition and enhanced forage production of this site is that many ranchers do not use these fenced grasslands for livestock grazing to any extent during the growing season. In the basin, 54 percent of this vegetal site is in either the medium or fairly high forage production classes.

Past heavy overuse of the Humboldt Basin's range and watershed lands, primarily by domestic livestock, has resulted in widespread deterioration of these lands. This continuing deterioration is the basin's most critical range problem. In several of the Humboldt sub-basins - Pine Valley, Reese River, Sonoma, Little Humboldt, principally - the destruction of the perennial grass and forb cover wrought by the crowding of overly large livestock numbers on steep, thin-soiled, critical watershed lands was at the same time matched or exceeded by the wholesale removal of extensive pinyon, juniper, aspen, and mountain mahogany stands for fuel and mine timbers. This removal was particularly heavy from the early 1860's until the 1890's, in many portions of the Pinyon, Sulphur Springs, Toiyabe, Shoshone, Sonoma, East, Humboldt, and Santa Rosa Ranges during the Reese River, Humboldt, and Eureka silver booms and the mining activities in the Santa Rosas. (See photograph 69.)

Photograph 69. - Almost complete removal of vegetal cover by heavy grazing, both domestic livestock and big game, has bared this steep slope at the head of Reese River to topsoil loss through both sheet and rill erosion. This has resulted in pedestalling or partial burial of the few remaining browse clumps, and the formation of an erosion pavement. FOREST SERVICE PHOTO

The depletion of the climax vegetal cover and forage resources through thinning, loss, or removal of the perennial grasses, forbs and browse and the timber overstories over the years was followed by the invasion of worthless, nonpalatable, or poisonous plants, or resulted in the virtual baring of the soil itself through plant cover removal or destruction. The action of spring snowmelt waters or heavy summer convection storms on these damaged slopes, benches, and basins in turn led to overland flows and soil loss through sheet erosion and gullying. The meadow lands along most tributary streams, and along many stretches of the Humboldt River itself, have been covered with the sedimentation from this erosion of the slopes above, or the meadows have been drained and desiccated by channel headcutting and degradation along the streams coursing through them.

In recent years, livestock numbers have been reduced substantially on both private and Federal range lands. In many portions of the Humboldt Basin, range overuse today is more a distribution and livestock management problem than one of excessive livestock numbers. Wholesale timber removal or destruction on vital watersheds has been stopped; at least some semblance of timber management is being applied to most of the basin woodland areas. In addition, the development of a program of fire protection for most of the basin's wild lands has generally helped to reduce widespread and destructive range and forest fires, although continued improvement is necessary in this important facet of land management.

Other Problems and Their Solutions

An equally important problem relative to the Humboldt Basin's range and watershed lands is not inherent in the physical features of these lands and their water, vegetal, and soil resources, but pertains entirely to the people responsible for the lands. However, this problem is directly related to that discussed in the previous paragraphs. It is concerned with the lack of knowledge, training, and experience on the part of range managers and users in the science of range ecology, and the management of livestock for uniform and proper utilization of the available range forage in the practical application of these ecological principles.

Much has been done in the way of fencing, stockwater development, seeding, salt distribution, management of livestock, and protection of the vegetal cover from fires (see photograph 70). This is particularly true in the Lamoille, Starr Valley, and Jiggs areas on the western slopes of the Ruby Mountains, on both Federally and privately owned range. However, what has been accomplished to date is only a scratch on the surface, with relation to what should and must be done throughout the entire Humboldt Basin. To achieve maximum forage production, as detailed in each of the sub-basin reports, a great amount of fencing needs to be done, and 1,019,000 acres of suitable range seeded where there is little or no chance of native perennial vegetal restoration. In addition, numerous stockwater sources need to be developed, and many land treatment measures installed, such as gully plugs, contour trenching, stream channel stabilization structures, erosion-proofing or relocation of old or improperly located roads, etc.

Photograph 70. - Stockwater well, windmill, and trough serving two fenced ranges on Maggie Creek, in the sub-basin of that name. To achieve uniformly proper livestock utilization of the Humboldt Basin's usable forage resources, many more of these developments, along with fencing, proper management of stock on the range, etc., need to be installed.

FIELD PARTY PHOTO --- 6-923-12

Change in Class of Livestock Use

As a desirable solution to one of the Humboldt Basin's serious range problems, it is suggested that a change in the class of livestock using the shadscale-bud-sagebrush rangeland be made. This range area makes up 14 percent of the basin area, and is currently being grazed chiefly by cattle. Cattle are not the most efficient or suitable users of this vegetal site, because they do not graze shadscale or bud sagebrush to any extent, and therefore cannot return the most pounds of meat per acre from this type of range. More importantly, however, over the years cattle use of this site, which has been proven to be more suited to sheep use, has concentrated itself particularly upon the highly relished winterfat (white sage) areas of the benches, flats and bottomlands, and has resulted in the virtual elimination of winterfat as a range type (see photograph 71).

The heavy concentration of cattle on this range, in many cases amounting to yearlong use, has resulted in nearly complete depletion of not only winterfat but also the perennial forage grasses, such as Indian ricegrass, needlegrass, squirreltail, and Sandberg bluegrass. Much of this vegetal site is seriously gullied, and has lost from light to heavy amounts of topsoil. The sparse plant cover remaining is pedestaled or hummocked. The few springs present have been trampled in, and furnish insufficient or very poor quality livestock water. Whether cattle are using this vegetal site for only part of their range forage, or for all of it, they are starving or on bare subsistance while here, and cannot be returning any money in pounds of beef gain to the users.

To bring this once important range area back to its pristine desirable forage species composition will require, at least initially, the elimination of all use, or a change in class of livestock use to sheep. Results of research at the Desert Range Experiment Station on similar shadscale ranges in western Utah have shown that browse plant composition in particular can be markedly changed or controlled in a relatively short period of time by the class and time of livestock use on this vegetal site.

Sheep are more efficient users of shadscale and bud sagebrush, and will return more pounds of meat per acre than cattle on this range, in its present condition. Controlled use of the shadscale site with sheep will restore the presently upset species composition balance, with its heavy preponderance of shadscale and bud sagebrush, and its marked dimunition or virtual elimination of the winterfat and perennial grasses which once made up a heavy part of the vegetal cover. These better cattle forage species will thus be allowed to return; sheep, unless forced to do so, eat only minor amounts of winterfat and the perennial grasses.

Upon the return or re-establishment of the better forage species, controlled use of this vegetal site by cattle could then be resumed. If the site is used by either class of stock as a winter range, however, Desert Range Experiment Station findings indicate that such use should be confined only to the early and middle portions of the winter season. Late winter and early spring grazing, when the shrub species are beginning their spring growth, is highly injurious, particularly to winterfat. This improper season of use, coupled with the previously discussed imbalance of shrub species utilization by cattle in their fondness of winterfat and their virtual ignoring of other species in the browse overstory, has led to the present almost universally depleted condition of the Humboldt Basin's shadscale vegetal sites.

The Range Manager's Responsibility

Managers and range users must also realize that the growing and proper use of

Photograph 71. - Cattle overuse of winterfat-bud sage flats and bottomlands throughout the Humbolt basin has resulted in the virtual elimination of winterfat as an important forage species. Shown here is a winterfat (white sage) area on Gilbert Creek, in the Reese River Sub–Basin, where thinning of the winterfat cover from grazing pressure has resulted in sheet and gully erosion, stand desiccation, and the invasion of big sagebrush, shadscale, and worthless forbs, all clearly evident in the foreground and middle distance of the photograph. FIELD PARTY PHOTO --- 6-770-12

grasses or other desirable livestock forage plants, not the production of pounds of beef, is the most important part of their operation. It is true that the two go together, but the second factor logically follows the first; the raising of forage must always be paramount, and all livestock raisers and range managers must adjust their operations and thinking to this, if range and watershed forage production is ever to reach its maximum potential with coincident livestock use. In order that forage plants may reproduce, maintain good plant vigor, protect the watersheds, and furnish optimum production, several criteria must be met. Paramount among these is the necessity that the livestock operator and land manager have knowledge of the adjustment of livestock use to equate with varying range forage production conditions from year to year, be willing and able to do so, and faithfully perform the varied and necessary management chores year after year.

It also requires that the land manager recognize all early indicators of deterioration of soil and vegetal resources on the privately or Federally owned lands for which he is responsible, and take prompt measures for the correction or the elimination of contributory causes, before deterioration of the resources become overly difficult or costly to rectify. All too often this was not done in the past history of land and livestock use in the Humboldt Basin, as witness the advanced stages of soil and vegetal deterioration and impaired water-holding capacity of too many of the basin's vital watershed areas, extensive portions of which are now extremely difficult or costly to rehabilitate and restore.

Last but certainly not least, if the progressive deterioration of the Humboldt Basin's soil and vegetal resources, and the impairment of their important water-holding and storage function, is permitted to continue at the present rate, its calamitous effects will become even more apparent, in varied and disagreeable ways.

Eventual Effects of Mismanagement

All of these factors will have a direct and disturbing effect upon the basin's general welfare, and certainly upon its financial outlook and hopes for a continued sound and orderly development. More specifically, some of these harmful effects would be:

1. Lessened yields of pounds of beef or mutton.

2. Increased costs of livestock production.

3. Diminished or sporadic water yields from watershed areas, with damaging floods and high water being succeeded by sharply reduced or nonexistent stream flows.

4. Increasing floodwater, sedimentation, and pollution damages, or the potential for such damage, to downstream improvements, running the gamut from reservoirs, irrigation systems, and cultivated areas to ranch homes, towns, cities, roads and railroads.

5. Livestock losses from miring, drowning and starvation.

6. Increasingly elaborate and progressively more costly structures for flood protection systems needed, which in the final analysis would only protect against floodwater without correcting the evil at its source - a deteriorated range watershed.

7. Loss of human life from sudden floods and freshets.

8. Gradual dimunition in quantity and quality of water available for domestic, agricultural, and fisheries use.

9. Increase in fire potential, through the invasion of inferior highly inflammable species.

Rangeland Potential

It is estimated that average annual usable range forage production in the Humboldt Basin can be increased 2.4 times by brush overstory removal and seeding on all suitable sites, and rehabilitating weed-infested or brushy areas not suited for seeding by other measures, such as selective aerial spraying (see photographs 23, 39, and 67). Other range management and improvement measures would include the following: (1) Stocking only on the basis of proper numbers, on range suitable to grazing use; (2) deferred-rotation grazing where feasible; (3) proper livestock distribution by salting, fencing, water development, and riding, and (4) fitting each class of livestock to its best-suited vegetal site (see photographs 65, 72, 73 and 74).

Photograph 72. - Intermediate Mountain Slopes vegetal site in the fairly high forage production class, Humboldt National Forest, Ruby Mountains Sub-Basin. This range, with its scanty browse overstory and its thick cover of Idaho fescue, bluebunch wheatgrass, and Nevada bluegrass, is well suited to cattle use. FIELD PARTY PHOTO --- 6-938-3

Photograph 73. - Example of an Intermediate Mountain Slopes vegetal site in the fairly high forage production class: This area, suitable for cattle use where slopes are not overly steep or water too distant, is in the vicinity of the Carlin Gold Mining Company Mill, Maggie Creek Sub-Basin. Great Basin wildrye is here an important component of the desirable perennial grasses making up the bulk of the vegetal cover. FIELD PARTY PHOTO

Photograph 74. - Upland Benches and Terraces vegetal site well adapted for cattle use at the mouth of Rock Creek, Battle Mountain Sub-Basin. Thurber needlegrass, needle-and-thread, squirreltail, and Sandberg bluegrass make up the bulk of the grass species understory to the scattered big sagebrush. FIELD PARTY PHOTO --- 6-782-10

Grazing pressure on steep, thin-soiled watershed areas can in many cases be lightened or eliminated by the moving of excess livestock numbers to more adapted range which has been seeded, or selectively sprayed for brush or weed removal to liberate the perennial grass understory. Good examples of this practice are to be found on the Austin and Reese River Ranger Districts of the Toiyabe National Forest. (See Report Number Eight, Reese River Sub-Basin.)

Fire Protection Plans, Present and Projected

All Federal lands in the Humboldt River Basin are covered by fire plans of the Forest Service or the Bureau of Land Management. Only portions of the private lands are covered by fire plans in cooperation with the Nevada Division of Forestry. The private lands covered by fire plans are all such lands in Elko County and portions of the private lands in Humboldt County, mainly around Winnemucca and adjacent to the Santa Rosa Range. The private lands in the other counties (Eureka, Lander, Pershing, and Nye) are not adequately covered by fire plans. The lack of fire protection for these lands raises many problems with the State and Federal agencies when fire suppression becomes necessary.

The Nevada Division of Forestry has all the private lands in Elko County organized into a fire control district under provisions of State Law and the Federal Clarke-McNary Act. In Humboldt County there are five organized county fire protection districts which cooperate with the Nevada Division of Forestry. Basically, however, wildland protection within these Humboldt County districts is the responsibility of each individual district's elected Board of Directors.

The Nevada Division of Forestry has responsibilities for fire control only on those private lands within organized fire districts, or on lands covered by specific agreements.

The Bureau of Land Management and the Forest Service have responsibility for Federal lands. However, because of the intermingled private-Federal ownership land pattern so prevalent in the Humboldt Basin, cooperative fire protection master agreements have been prepared and signed between the State and Federal agencies for fire suppression.

These master agreements for fire control are between (1) the Regional Forester, Region Four, U.S. Forest Service, and the State Director, Bureau of Land Management; (2) the Regional Forester and the State Forester of Nevada; and (3) the State Director, Bureau of Land Management, and the State Forester. Within the framework of the master agreements, annual operating plans are prepared (1) between the various Bureau of Land Management grazing districts and the Humboldt and Toiyabe National Forest Ranger Districts, and (2) the Nevada Division of Forestry Area Foresters and national forest Ranger Districts. (These operating plans are covered in more detail in a subsequent section of this discussion.)

The cooperative agreements clearly state the kind and the amount of assistance or cooperation to be furnished, the responsibility of each agency, and the extent or limit of that assistance. Agreements, in some cases, provide for exchange of assigned protection areas for increased efficiency.

There are two National Forests and three Bureau of Land Management grazing districts in the Humboldt River Basin. In addition to the cooperative master agreements existing between Federal agencies and the Nevada Division of Forestry, the Bureau of Land Management, as well as the national forest Ranger Districts, have worked out mutual aid agreements among themselves for the handling of fires in isolated or inaccessible portions of one district which may be more easily or expeditiously reached by the suppression crews of an adjoining district. Where needed, this same type of agreement is also entered into between national forest Ranger Districts and Bureau of Land Management districts. All such mutual aid agreements are then incorporated in the annual operating plans between the two Federal agencies, as discussed in a subsequent paragraph.

The Nevada Division of Forestry, the Bureau of Land Management, and the Humboldt and Toiyabe National Forests each year prepare annual fire mobilization plans for their respective organizations. These fire plans are essentially lists of fire-fighting equipment available, where located, personnel available and their qualifications, the chain of command on the actual fire, and a delineation of the location and extent of outside help available during fire emergency situations. All agencies have equipment and supplies cached at various ranches or other strategic locations throughout the Humboldt Basin; the location and equipment inventory for each of these caches is also included in the fire plans. The equipment and supply caches are readily available for initial attack by volunteer per diem fire guards and their crews who are located nearby, or for the use of any other fire control agency.

In addition to the preparation of annual fire mobilization plans, each year the fire control officers and district administrators of the Toiyabe and Humboldt National Forests, the Nevada Division of Forestry, and the Bureau of Land Management meet together on mutual fire protection problems. At that time other plans, known as operating plans, are prepared or revised for the ensuing fire season.

One of these operating plans is made between each of the two Nevada national forests and the Nevada Division of Forestry, as well as between the Bureau of Land Management and those national forest units. Each operating plan contains, as a minimum, the following four items:

1. Fire protection organization of each party, including location of personnel and period of employment, location of standby crews, and fire equipment. Provision for each party to notify the other when significant changes are made in the organization.

2. Map showing the area on which the parties agree to take initial action for a specific distance across the protection boundary of lands under the jurisdiction of the other. Where these mutual aid areas are specifically delineated in the various master agreements, they cannot be changed in the annual operation plans.

3. Exchange of protection and firefighting facilities which are available for cooperative use, subject to each party's regulations and procedures; exchange of information concerning fire protection cooperative agreements with other fire protection agencies.

4. Each party's procedures and responsibilities for:

   (a) Issuing burning permits.

   (b) Initiating and putting into effect closure orders.

   (c) Availability of detection communication, access, and other fire control facilities.

The various Ranger Districts of the two national forests in the Humboldt Basin also prepare annual fire prevention plans, which are separate from the fire mobilization and annual operating plans. These prevention plans analyze man-caused fire problems on each Ranger District, and spell out the action necessary to reduce the occurrence of man-caused fires to certain prescribed minimum goals.

During recent years a fire suppression air tanker service, consisting of two air tankers and a lead plane, has been stationed at Elko throughout the fire season. The air tankers are kept loaded with fire retardant mixtures, and in less than an hour can reach the most remote or inaccessible areas of the Humboldt Basin. A supply of the fire retardant mixture, with crews to quickly load it into the planes after each drop, is always on hand during the fire season. Additional air tankers are available from the Carson City Air Center, and also out-of-State, should any emergency arise which would require their use.

Outside help from within the State is available to all agencies for the fighting of fire. This outside help consists mainly of crews specially trained in firefighting techniques. Such crews are available from the Nevada Youth Training Center at Elko, and from the Nevada State Prison inmate honor camp at Spooners Summit, near Carson City, both under the supervision of the State Forester. In addition, several Indian reservations in the State, including the Pyramid Lake and Owyhee Reservations, can furnish highly trained fire crews. Over and above these specially trained firefighting crews within Nevada, in extreme emergencies additional hot-shot crews, both Indian and white, may be obtained from Oregon, Idaho, Arizona, and New Mexico. These out-of-State crews can be transported in a few hours by plane to any fire area.

Photograph 75. - The Boulder Flat Fire, a particularly troublesome component of the 1964 Elko County Fire Storm, is shown here building up to its big run on August 18, 1964. The view is east across Boulder Flat toward the Tuscarora Mountains. Battle Mountain Sub-Basin.
FIELD PARTY PHOTO --- 8

Additional aerial and ground support for fires on public domain land and the national forests is available from the newly established Boise Interagency Fire Center, Boise, Idaho. The Fire Center maintains firefighting resources, and also coordinates requests for support from Bureau of Land Management units in other States.

The Nevada Division of Forestry has recently stationed a full-time Area Forester at Elko. His primary job is to strengthen State and local capability for fire prevention and suppression for State and private lands in the Humboldt Basin, particularly in the upper portion. He works closely with ranchers, volunteer fire departments, the Bureau of Land Management, and the Forest Service in bringing about better fire protection for all lands in the Humboldt Basin through improved facilities, and the coordinated and cooperative efforts of all concerned.

Present equipment, personnel and organizations are capable of controlling most fires with minimum damage when fires occur within a reasonable distance of initial attack forces, and when burning conditions are not extreme. However, there are still many areas relatively unprotected. The 1964 Elko County Fire Storm, when over 300,000 acres burned within the Humboldt Basin, clearly indicated what still may happen in a bad fire year (see photograph 75). There is need for more and better firefighting equipment, more trained personnel in firefighting, and additional locally organized fire control districts for the protection of private lands. In addition, the following presuppression activities need to be strengthened:

1. More widespread and aggressive fire protection, and improved fire prevention and patrol measures, commensurate with the increased public use.

2. The recognition and delineation of high hazard areas from the study of past fire occurrence maps and fuel type maps, as well as keeping posted on new cheatgrass area buildups. Where possible, conversion from high fire hazard species to a lower fire danger cover type should be made.

3. Intensified and more diligent inspection and hazard elimination along the railroads and highways. Insistence that railroads adhere closely to the Nevada fire laws with respect to fireproofing of diesel locomotives. Trucking firms, mining operations, and contractors using internal combustion equipment should also be checked for compliance with this section of the fire laws.

4. Improvement of the use of proven national fire danger rating systems.

5. Improved fire detection and radio communications.

6. Better integration and use of cooperator ranch and volunteer fire crews in State and Federal fire control organizations.

7. Hazard reduction in connection with road maintenance and roadside recreation site development.

8. Increased cooperation by all counties with the Nevada Division of Forestry - particularly those not presently cooperating - to provide better fire protection on private land.

9. Strategic location of initial attack forces in high hazard areas.

Recreation

There is a pressing need in the Humboldt River Basin, as well as in the State of Nevada and the United States, for increased recreation areas and facilities. The demand for recreational activities in Nevada is reflected in the upward trends in resident and non-resident licenses sold for hunting and fishing, and in the increase in numbers of out-of-State visitors. A study of the recreation use reports from the Ranger Districts of the Humboldt and Toiyabe National Forests within the basin reveals a sharp increase in forms of recreation use on those districts from 1950 to 1964, and an ever-growing demand for improved campground facilities. As the Sierra Nevada recreation use areas in western Nevada and eastern California become more and more heavily used with the population buildup there, the recreation use potential of the Humboldt Basin, with its many isolated and undeveloped areas of scenic grandeur and lonely beauty, will become increasingly important.

The Forest Service and Bureau of Land Management, under their inventories taken for the National Forest Recreation Survey (NFRS) and the Outdoor Recreation Resources Review (ORRR), respectively, have plans to develop camp and picnic sites throughout the Humboldt Basin on the Federal lands they administer. These sites will be developed as rapidly as funds permit. Municipalities and county governments, as well as at least one utility, the Pershing County Water Conservation District, are also involved in the development of public recreation areas.

National reports indicate the demand for water-based recreation is increasing more rapidly than the demand for outdoor recreation in general. As stated in the report by the Outdoor Recreation Resources Review Commission, "Wherever they live, most people seeing the outdoors look for water - to swim and to fish in, to boat on, to walk, picnic and camp by, and just to look at".

There are opportunities for developing water-based recreation in the Humboldt Basin, as evidenced by the 12 or more possible dam sites inventoried by the Field Party, the three dam sites proposed by the Corps of Engineers, the many perennial streams, the six or more existing ponds and reservoirs that can be reached by automobile, and the many lakes or streams in the Ruby and Jarbidge Mountains and the Toiyabe Range which can be reached by hiking or on horseback.

A number of opportunities exist in the Humboldt Basin whereby private landowners can provide a large part of the recreation need, with income to the owners and satisfaction to users. These range all the way from the simple pleasures of hiking, swimming, and bird watching, to packhorse camping and full summer vacations, either on their own lands or on adjacent national forest or public domain lands. Currently, there are a few ranches offering horseback riding, packhorse camping, and horse and guide service to hunters on this basis. At least one rancher is charging a fee for permission to stream-fish and hunt on his property, but offers no other services (see photograph 76). There may be opportunities for land owners next to populated areas to develop ponds for fishing and picnicking in the summer and skating in the winter. Excavated pits in areas of high water table along the Humboldt River would be an example of this type of development. In this area where livestock raising is the principal enterprise, the "vacation farm" concept might have special appeal and value for city children.

Opportunities for developing wintertime recreation are not as numerous or as varied as those for summer. The Ruby Mountains, within the Humboldt National Forest, probably offer the best location for ski area development. Records of snow measuring courses in Lamoille Canyon indicate snow depths to be adequate for skiing from January through April. A development here would have possibilities for both summer and winter recreation activities, and with the completion of the projected all-weather forest highway to the head of Lamoille Canyon, these possibilities would become reality. Other locations where snow depths may be sufficient to warrant eventual successful winter recreational developments are Big Creek in the Toiyabe Range, Water Canyon in the Sonoma Range, the east slopes and basins of Star Peak in the Humboldt Range, and the Hinkey Summit-Martin Creek Basin area of the Santa Rosa Range. There are an unknown number of places where snowshoeing and ice-skating could be developed.

Within the Humboldt Basin's boundaries are myriad points of local, State, and national historical significance. In addition, there are areas with great possibilities for such hobby-type phases of recreation as rock collecting and Indian artifact hunting (see photograph 77). These are being increasingly sought out by tourists, historians, and hobbyists in general, from within and outside Nevada. With heightened interest of most Americans in their historical heritage, which will undoubtedly continue to build up in the future, these locations will become of greater importance, and as such will need increasing consideration for protection and preservation. The Recreation Developments sections of the sub-basin reports contain lists of the most important areas for each sub-basin.

Photograph 76. - *Chinese pheasant rooster along a Lovelock Valley road, Lovelock Sub-Basin. This pheasant species fares better in the Valley than perhaps any other place in the basin. The farm and ranch grain fields there furnish recreation for many bird-hunters each fall.* SCS PHOTO --- 6-813-4

Photograph 77. - *Indian artifacts collected in or adjacent to the middle and lower reaches of the Humboldt River Basin.* SCS PHOTO --- 3-4236-10

Authorized Projects

The Humboldt River Project, proposed by the U.S. Army Corps of Engineers, was authorized by the Flood Control Act of 1950. This project consists of three upstream reservoirs and channel improvements on the Humboldt River, for the primary purpose of flood control and water conservation. The reservoirs are located (1) on the South Fork of the Humboldt River at the Hylton site, with 120,000 acre-feet gross capacity; (2) on the North Fork of the Humboldt River at the Devil's Gate site, with 80,000 acre-feet gross capacity; and (3) on Mary's River at the Vista site, with 50,000 acre-feet gross capacity. Currently, the Humboldt River project is classified in the Active category. Funds for detailed designs, however, will not be requested until local interestes indicate their willingness and ability to furnish the requirements of local assurances. The Corps of Engineers also has authorization for levee construction as a small flood control project on Reese River, at Battle Mountain.

There are four projects which have been authorized for planning under the Watershed Protection and Flood Prevention Act, Public Law 566, as amended. The planning on the Elko Watershed is completed, and authorization for construction is pending approval by Congress. This project is sponsored cooperatively by the Humboldt River Soil Conservation District and the City of Elko. Structural measures to be installed to reduce floodwater and sediment damage within the city of Elko consist of three floodwater retarding structures, to be located on the South Side Wash, Eight Mile Creek, and the Fifth Street Wash. A multiple-purpose structure, providing recreation facilities, municipal water storage, and floodwater and sediment protection, will be installed on Kittridge Creek.

The Lovelock Watershed, sponsored by the Big Meadow Soil Conservation District and the Pershing County Water Conservation District, has been authorized for planning; currently, investigations are being conducted to obtain information for the development of a plan. Improvements under consideration pertain to irrigation, drainage, floodwater and erosion control, watershed protection, and recreation.

The Susie Creek Watershed was planned in 1956, and the Bishop Creek Watershed was authorized for planning in December 1961. These two projects are currently inactive, because of lack of local interest. (See photograph 78.)

Public Law 566

The Humboldt River Basin Survey revealed possibilities for at least 20 project watersheds that might qualify under the Watershed Protection and Flood Prevention Act, Public Law 566, as amended. The names and locations of the proposed projects, together with the types of benefits that might be achieved, are listed in table 18 and figure 4. About one-third of the Humboldt Basin acreage could be treated through these projects. The principal benefits to be gained, as may be noted from the table, include watershed improvement and irrigation water management. The general public would derive direct benefits from most of these projects through recreational features, and indirect benefits through improved watershed protection.

A number of drainages, other than those listed in table 18, were investigated by the Field Party to determine their feasibility as Public Law 566 projects. It was determined, however, that under the present interpretation of the act, these areas would not qualify, because of the land ownership pattern or for some other reason. Rock Creek, in

Photograph 78. - The constriction of the Susie Creek bottomland seen in the middle distance of this aerial view marks the site of a proposed Public Law 566 structure.
FIELD PARTY PHOTO --- 6-694-3

the Battle Mountain Sub-Basin, is an example. In this drainage there is a need for watershed improvement and gully control. In addition, flood waters emanating from this drainage have caused livestock losses in lower Boulder Valley, and damage to agricultural lands in both lower Boulder Valley and along the Humboldt River flood plain. There is a reservoir site on lower Rock Creek with sufficient capacity for flood control, irrigation water storage, and recreation development. The acreage above this site, however, is greater than 250,000 acres. Another reservoir site on upper Rock Creek could be used for irrigation water storage, partial flood control, and recreation. However, the benefits from a structure at this site would accrue to only one land owner.

The development of project operations would need to be initiated by a local sponsoring organization representing the landowners and operators. The sponsoring organization could initiate such action by submitting an application for watershed planning assistance to the Director of the Nevada Department of Conservation and Natural Resources.

Under the provisions of the Watershed Protection Act, and the operations procedures as developed by the U.S. Department of Agriculture, a local sponsoring organization would provide needed land rights for structural improvements, and assume the responsibility for contracting the structural work and for its subsequent operation and maintenance.

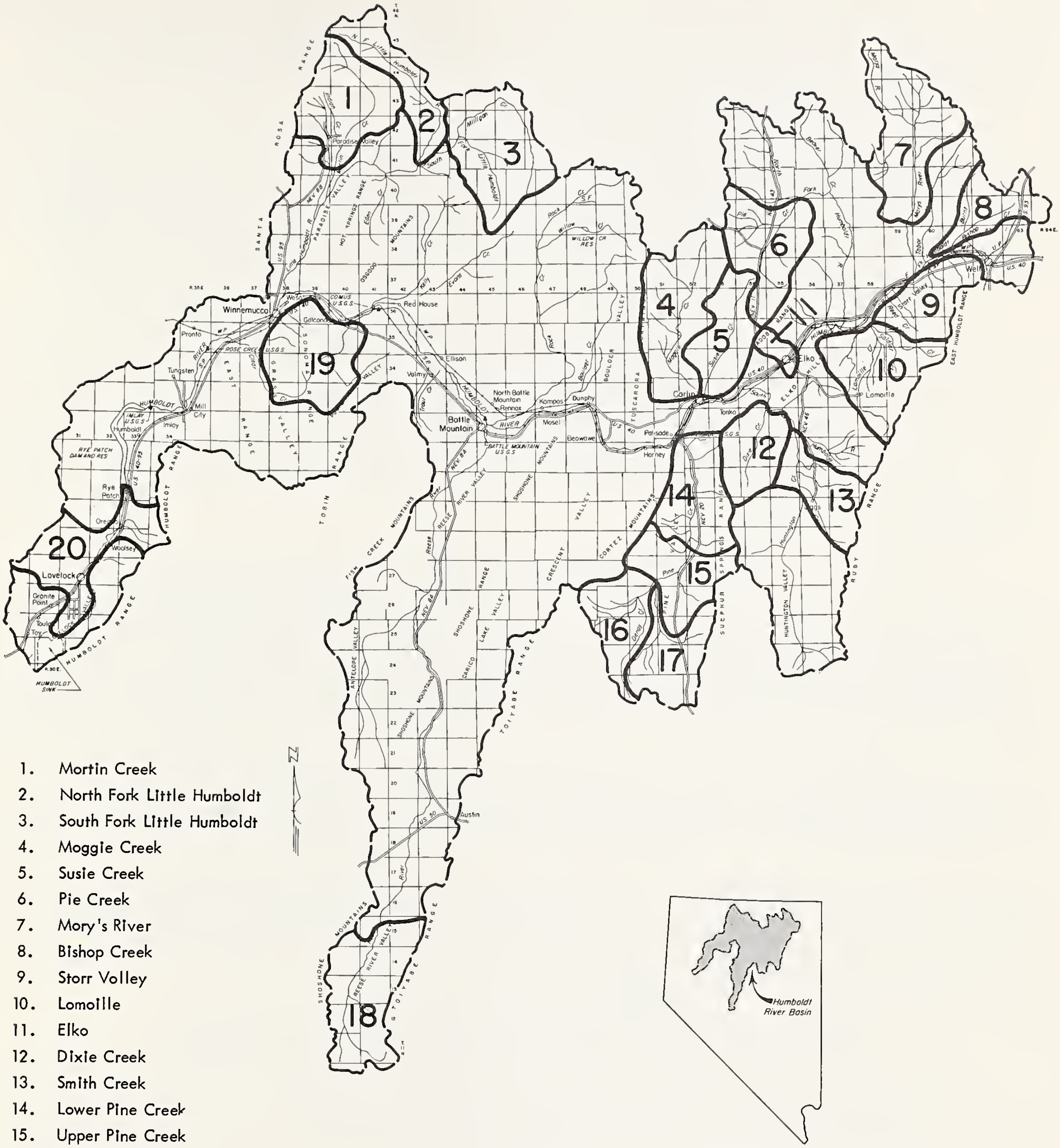
The landowners would have responsibility for the installation of land treatment measures on the privately owned lands. Cost-sharing and credit assistance could be made available by the U.S. Department of Agriculture for such work.

Table 18. -- Benefits expected from possible project-type developments, Public Law 566, Humboldt River Basin Survey

Watersheds	Recreation	1/ A.W.M.	Floodwater and erosion control	Watershed protection	Remarks
1 Martin Creek	x	x	x	x	
2 North Fork Little Humboldt	x	x	x	x	
3 South Fork Little Humboldt	x	x	x	x	
4 Maggie Creek	x	x	x	x	Application for planning assistance filed.
5 Susie Creek	x	x	x	x	Planned in 1956 - inactive.
6 Pie Creek	x	x		x	
7 Mary's River	x	x		x	
8 Bishop Creek	x	x		x	Planning authorized - inactive.
9 Starr Valley		x		x	
10 Lamoille		x		x	
11 Elko	x		x	x	Planning completed.
12 Dixie Creek			x	x	
13 Smith Creek	x	x		x	
14 Lower Pine			x	x	
15 Upper Pine			x	x	
16 Denay Creek			x	x	
17 Henderson Creek			x	x	
18 Upper Reese	x	x	x	x	
19 Sonoma	x		x	x	Application for planning assistance filed.
20 Lovelock		x	x		Planning authorized.

1/ A.W.M. - Agricultural water management.

Source: Humboldt River Basin Field Party



1. Mortin Creek
2. North Fork Little Humboldt
3. South Fork Little Humboldt
4. Moggie Creek
5. Susie Creek
6. Pie Creek
7. Mory's River
8. Bishop Creek
9. Storr Volley
10. Lomoille
11. Elko
12. Dixie Creek
13. Smith Creek
14. Lower Pine Creek
15. Upper Pine Creek
16. Denoy Creek
17. Henderson Creek
18. Upper Reese
19. Sonomo
20. Lovelock

——— ——— Basin Boundary

————— Proposed Project Watersheds Boundory

LOCATION MAP

HUMBOLDT RIVER BASIN, NEVADA

SHOWING PROPOSED PROJECT WATERSHEDS

SCALE IN MILES

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE M-4480

The Federal land-managing agencies would assume responsibility for the installation of land treatment measures on the Federal lands they administer. In addition, the Forest Service would provide technical assistance and determine adequacy of treatment for the State and privately owned forest lands.

Funds appropriated under the Watershed Protection Act can be made available to defray the cost of construction of the structural improvements for the reduction of floodwater and sediment damages, and to share in the construction cost of structural improvements for irrigation, drainage, fish and wildlife, and other recreation features. These funds may also be used to provide cost-sharing assistance to local sponsors for the acquisition of land, easements and rights-of-way needed for public recreational developments.

PROCEDURE FOR THE DEVELOPMENT OF SOIL SURVEY MAPS, VEGETAL SITE MAPS, AND FORAGE PLANT PRODUCTION CLASS DATA

Preparation of Soils Maps

Generally, the information needed from the soil reconnaissance survey of each sub-basin of the Humboldt Basin was interpretations or interpretable data regarding soil-water relationships (for hydrologic analysis), soil stability relationships (both surface erosion and mass-movement potentials), and soil-vegetation relationships. In the instant discussion, only the soil-vegetation relationship is discussed. Accordingly, there follows an explanation of the soil and vegetal survey procedures as they related to one another in the Humboldt River Basin Survey.

First, a soils map for each sub-basin was prepared, using Army Map Service 1:250,000 scale maps. The soil taxonomic units were classified into associations of phases of the Great Soil Groups, and delineated on the maps.

These association units were examined in the field to check their boundaries, appraise their real significance, and to determine and characterize the individual soil phases or miscellaneous land types in each association. The percentage occurrence of soil phases in each association of Great Soils Group phases was estimated, and recorded on the soils work map, as shown here:

$$\frac{\text{Map Symbol of Each Great Soil Group Phase in the Association}}{\text{Percentage of each of the above soil phases}}$$

On the soils map, this fraction might appear in this way:

$$\frac{\text{S1 - A3 - G1}}{\text{50 - 40 - 10}}$$

(For an explanation of the foregoing symbols, consult SOILS DESCRIPTION in the Appendix I section of any of the sub-basin reports.)

The percentage figures were used in the compilation of acreages for individual Great Soil Group phases.

Preparation of Vegetal Site Maps

At the same time the soils work on the aerial photos and the soils map was being done by the soil scientist, a work map of broad vegetal sites was being prepared by the Field Party forester or range conservationist. This map was compiled from such sources as Forest Service or Bureau of Land Management vegetal type maps, when available, and Forest Service range allotment analysis or BLM range condition maps. These source maps were checked in the field when deemed necessary, to be sure they accurately reflected and delineated present vegetal site boundaries and range conditions.

If it was found that the range type maps or range condition maps no longer accurately reflected present conditions, they were up-dated on the Field Party vegetal site work map. Before this was done, however, a field inspection of the vegetal sites in question was made by the Field Party specialists, accompanied on the ground by the District Ranger or other qualified technical people concerned, and spot-check range condition writeups were made. (No range condition determinations or alterations were ever made by Field Party personnel on any range area unless participated in and the results finally confirmed by the Forest Service, Bureau of Land Management, Bureau of Indian Affairs, or other Federal or State agency technicians and resource managers involved or concerned.)

Correlation of the Soils and Vegetal Site Maps

The final step in the preparation of the soils and vegetal map data involved correlation of the Great Soil Group association boundaries as delineated on each sub-basin soils map with the broad vegetal site boundaries shown on the vegetal site work maps. Except for small soil inclusions, the boundaries shown on the soils map had to reasonably match the vegetal site boundaries.

From these correlated range and soils maps, acreages of broad vegetal sites and the various range forage production classes were then computed, as well as the acreage of individual Great Soil Group phases.

Development of Forage Plant Production Class Data

Conversion of Qualitative Range Condition Classification Terms to Quantitative

Annual forage plant production class tables for the Humboldt River Basin Survey were first developed in lieu of, and as an alternative for, range condition classes. It early became apparent that disparities existed in terminology and techniques used by the various Federal agencies concerned in arriving at a determination of range condition classes - depleted, bad, poor, fair, good, excellent. Consequently, it was necessary for the Field Party to develop an alternate method of range condition classification, which could serve as a common denominator for the various agency classifications. Any method devised also had to meet the approval of the agencies concerned, and the data derived therefrom had to be readily convertible by technicians of the respective agencies to their individual qualitative terms of range condition.

To meet these criteria, adaptations of basic data in pounds of total usable forage produced per acre, air-dry weight, were substituted for the various range condition classes. These adaptations, from forage yield material originally developed by Mark Shipley of the

University of Nevada several years ago (1938-1941) for the Northeastern Nevada Cooperative Land Use Study, best met the aforementioned criteria involved in developing an alternative method of depicting range condition.

Next, qualitative range condition classifications (good, fair, poor, etc.) were converted to equivalent quantitative terms, in pounds of forage produced per acre. Accordingly, for the Humboldt River Basin Survey the good classification is included in the fairly high forage production class, and fair is included in the medium forage production class. The Bureau of Land Management's poor and bad, the Forest Service poor and depleted, and the Soil Conservation Service's poor were grouped together in one quantitative group: the low forage production class.

The excellent range condition classification was not used in the development of these quantitative range forage classes. The acreage of this class, confined as it is in the Humboldt Basin to the relatively few range areas which have been properly managed on a sustained-yield basis over the years, or to relict areas difficult of access, unsuitable, or inaccessible to livestock, was deemed to be relatively insignificant. Where found in suitable and accessible areas, the acreage of this range condition class was included in the fairly high forage production class.

Preparation of Forage Production Class Tables

In the tables as developed for the sub-basin reports of the Humboldt River Basin Survey, the forage yield columns were not specifically labeled as low, medium, etc. However, the column of highest forage production figures, on the left side of the forage plant production class tables in each sub-basin report, represents the fairly high forage production class. The middle column is the medium forage production class, and the right-hand column in each case is the low forage production class. It should be noted, however, that the forage yield columns as presented in tables 1 and 4 of this basin report are specifically labeled as these forage production classes.

Forage production class yields vary widely among the 12 vegetal sites, because of differences in inherent productivity. Accordingly, the original production figures for the northeast Nevada sites were expanded or adjusted, wherever new or additional plant clipping and weight data indicated the need. New figures were developed to cover those of the 12 sites not found within the bounds of the original study. In some cases, this meant increasing the original production rates for the three production classes involved, where newer and more applicable data indicated the desirability of a change, or to meet the condition outlined in the following paragraph.

Upper and lower limits of forage production rates were determined for each forage production class within the vegetal sites, to reflect the influence of climatic factors on forage production rates from favorable to unfavorable years. The upper limits of the lower forage production rate classes, and the lower limits of the next higher forage production class, in each case, were expanded slightly, so as to provide some overlapping between classes. This was done to compensate for the varying criteria used by the various agencies in determining qualitative range condition - i.e., good, fair, poor, etc. - and to insure that, on a quantitative basis, these criteria variances were minimized, and that a uniform rating of range condition on a quantitative forage production basis would be obtained. This expansion of the upper and lower limits of forage production rates resulted in maximum rates which were considerably higher than the production rates developed on the northeastern Nevada study, particularly in the big sagebrush-grass vegetal site. In many cases, the midpoint between the high and low rates of forage production represents a truer comparison with the original production figures.

The forage plant production rates given for each range forage production class in table 4 represent the total amount of annual usable forage produced for the sites in each sub-basin. (As noted in the footnote to the table, the figures represent not the highest or the lowest rates of production, but the median point for each class.) Simply defined, usable forage here is that amount of the current forage plant growth which is taken at the time the key forage plant species have been properly utilized - from 40 to not more than 50 percent of their annual growth, in the case of Idaho fescue or Nevada bluegrass, for example. Utilization studies made over many years reveal that if the key forage species are grazed to this 40 to 50 percent limit and no more, proper use of all other forage species of lesser value or occurrence in the stand will not be exceeded.

To facilitate the use of table 4, the following additional terms need defining:

1. The first term, total annual herbage production, is the total amount of all herbage, annual or perennial, palatable or nonpalatable, grass, forb, shrub, or tree, produced annually on a given area.

2. The second term, total annual forage production, represents the total amount of vegetal growth, annual or perennial, which may be palatable, nutritious, and available for range livestock.

Explanation of Grazing Use Efficiency and Its Application

The production figures in table 4 also presuppose another premise - 100 percent efficiency of use by livestock. Percent of efficiency, as used here, should not be confused with species utilization percentage. A grazing area used at an efficiency rate of 100 percent, for example, would represent that halcyon condition where all portions of the grazing unit are equally accessible to livestock, resulting in uniformly proper use over the entire area. Such a maximum degree of efficiency in livestock use as 100 percent, it will readily be seen, is not possible of achievement on most western rangelands. In the Humboldt River Basin, with its varying conditions of slope, exposure, topography, species composition, and available livestock water, this is particularly true.

Envisioning the time when all economically feasible range betterment, systems of management, and livestock distribution improvement measures advocated for the maximum potential development of each vegetal site are installed or in use, it is expected that maximum efficiency of use would approximate 50 percent. At the present time, this livestock use efficiency in the basin is estimated to approximate 25 percent. Many areas suited to livestock use are presently receiving little or no use, because of a lack of proper salt distribution, water developments, fencing, range seeding, selective spraying, etc., while many of the more accessible, better-watered areas are often overused. It will be difficult to improve this present rate of grazing efficiency until some or all of the systems of management and recommended measures of range and watershed restoration are put into effect.

Keeping this matter of grazing use efficiency in mind, it is not hard to see why the 100 percent efficiency forage production figures in table 4 cannot be used directly to determine the carrying capacity of any particular vegetal site, even though the figures themselves represent the pounds of usable forage under proper use - that is, up to 50 percent utilization of the key forage species present.

Therefore, anyone desiring to convert the production figures in the table to grazing capacity, would first be required to make a conversion on the basis of the percent efficiency of use envisioned and practical. To use production figures in the table without reckoning with these grazing efficiency percentages will lead only to false or misleading conclusions with respect to the grazing capacity of any given area.

Consideration of Herbage Yields on Cheatgrass Ranges

It should also be noted here that the forage production figures in table 4 do not represent herbage yields on cheatgrass ranges, or other areas producing temporary or expedient feed from annual forbs or grasses, with the exception of the low forage production class, principally in the Big Sagebrush-Grass vegetal site. Here, minimal amounts of cheatgrass production were included in the forage production rates for the class. This was done in recognition of the fact that use of cheatgrass or other annual forage plants will take place on poorly vegetated ranges with little or no perennial forage plant production.

This type of feed, then, makes up a significant amount of the forage produced on many depleted range areas in the Humboldt Basin, and as such doubtless represents forage upon which many ranch operations are completely dependent from year to year to round out their range operations. However, at best it constitutes an unsatisfactory range forage resource, because of its undesirable characteristics, and its wildly fluctuating rates of production from year to year. Any long-term plan of range betterment will of necessity need to consider only perennial grass, forb or browse species, which have value not only as good forage plants, but also as watershed-protecting and soil-binding species, and which are as fire-resistant as may be. Cheatgrass is a signal failure in all these categories, particularly with respect to retarding the spread of range wildfire. It represents the highest fire-hazard species found in the basin.

An additional point should be borne in mind in using the material presented in table 4. The forage production figures shown there are the midpoint between the high and low rates of forage production. In favorable years higher production rates are to be expected; conversely, in unfavorable years substantially lower production rates may be anticipated.

ECONOMIC ANALYSIS OF PROPOSED AGRICULTURAL IMPROVEMENTS IN THE HUMBOLDT BASIN *

This phase of the Humboldt Basin-Wide Report was prepared to indicate the economic feasibility of agricultural practices and structures that could improve the water and related land use in the basin. No attempt was made to estimate the benefits which would accrue from the control of floods and the prevention of flood damage. Most of the proposed improvements, however, would have flood-control benefits.

The purposes of this study were twofold. The first was to determine if the implementation of certain practices would increase farm income to individual farm and ranch operations. The second was to determine the economic feasibility of the proposals for the basin as a whole, and by sub-areas within the basin.

Methods and Procedures

In approaching this phase of the study, it was decided to evaluate the entire basin by dividing it into natural resource areas that had similar climatic, soil, range, water, and other natural resources and problems. Three sub-areas were selected, as they were natural divisions which would consolidate the many sub-basins within the overall basin, and which would divide the basin into natural but workable units. The three divisions were: (1) the upper basin, which included the Humboldt Basin above Palisade; (2) the middle basin, or that part of the Humboldt Basin between Palisade and Rose Creek; and (3) the lower basin, which included the Humboldt Basin below Rose Creek.

Cropland Analysis

Agricultural lands used for harvesting hay, for pasture, and for other crops in the Humboldt Basin are all irrigated (see photographs 79 and 80). There is no dry cropland acreage as such in the basin.

The primary economic tool used in making the analysis was budgeting. For the crop phases, individual crop enterprise budgets were made for each resource area under present operating conditions, using current costs and price projections based on historical data. Yields used were averages experienced over the past few years. Budgeting was used to calculate future income under conditions of proposed improvements. After the budgets were made, incomes were weighted according to cropping patterns, and thus a per-acre income for each sub-area could be calculated for present operations, and for the potential conditions following the installation of improvements. This method of arranging the data simplified comparisons made from the analysis.

* This analysis was done as a special study by William V. Neely, Agricultural Economist, University of Nevada, based on physical data supplied by the Humboldt River Basin Field Party and other sources.

Photographs 79 & 80. - A contrast between old and new hay-harvesting methods in the Humboldt River Basin. Photograph 79 pictures a native hay meadow being harvested with the once universally used horse-drawn mowers, while in photograph 80 a modern swather mows on alfalfa stand on the Horshoe Ranch near Beowawe.

SCS PHOTO --- 6-724-12 FIELD PARTY PHOTO --- 6-783-1

Rangeland Analysis

The budgeting system for rangeland analysis was based upon work done by Neely,[1] and as modified by the Humboldt River Basin Field Party.[2] This technique measures income to range operations by the animal product method, using a system which allocates a portion of the final product to livestock cost and the remainder to rangeland as a determinant of income for budgeting purposes. Animal products were determined from forage weight estimates made by the Field Party range specialists. These estimates were classified by resource area, vegetal site, condition, and class, and were expressed in terms of air-dry usable forage. Data of operation costs on rangelands were based on earlier studies done by Neely.[3] Private and Federal lands were considered separately because of operational cost differences; primarily taxes. Costs were determined for range operations under both current operating conditions, and for conditions after improvements were made. Again, the major cost difference was in the tax base.

A major problem of economic analysis of rangeland has always been proper discounting of potential income to reflect its present value. Discounting was also a problem in this analysis. Traditional discounting techniques could not be used because of the complexity of results from the mixture of improvements, and because available data did not reflect year-by-year results of improvements. The average annual benefit from improvements was calculated for comparison with the average annual cost of improvements in lieu of usual discounting procedures. Calculations were based on the following assumptions: (1) no measurable results from improvements would be shown in the first year; (2) maximum results from improvements would not be realized until the 20th year; (3) management levels would facilitate full development of the suggested improvement package; and (4) incomes to ranches would be maintained at present levels in the absence of improvements. With these assumptions, the calculation of average annual benefit was accomplished by subtracting present net income from expected net income in the 20th year and dividing by two.

Costs of most improvements were amortized over a 20 year period, at a market rate of interest (6 percent).* Using the market rate of interest for the entire improvement package has the effect of increasing the average annual cost, as compared with using the discount rate of interest for public investment in improvements. The higher average annual cost has the conservative effect of lowering the calculated benefit-cost ratio. Also, benefits from some improvements can be expected beyond the 20th year. Such benefits could be considered as "free", since their cost would be borne within the period of repayment. These factors partially offset the lack of discounting future incomes, so that the resulting benefit-cost ratio can be used with a degree of confidence in decision-making.

Cost of Improvements

Structures and measures needed to improve the watersheds in the basin were determined by specialists in the Field Party (tables 8, 9, and 10). Costs were based on current prices, and from experiences and estimates of persons from the Bureau of Land Management, Forest Service, and the Soil Conservation Service. Length of life of structures and measures was determined according to a practical amortization period. This length of life was never extended beyond 25 years for the purposes of this analysis, even though the useful structural life might actually be much longer.

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* Some permanent structures, such as dams, were amortized over a 25-year period.

Range improvement practices and structures were amortized for a 20-year period, since this was selected as the period of development; however, for permanent structures the 25-year period was again used.

All improvements measured were amortized at a 6 percent interest rate, to arrive at an average annual cost for repayment. Estimated operation and maintenance costs amounted to 5 percent of the annual cost.

The numbers and costs of improvements, as shown in the appended tables, represent the best information available at this time from all agencies and individuals involved.

It should be recognized, however, that these figures include estimates, and that estimates are subject to departure from conditions actually encountered. Obviously, any departure from estimated data would influence changes in calculations.

Cost Data

Cropland Analysis

As described earlier, the analysis of cropland was made for each sub-area on a weighted basis. Crop budgets were made for improved meadow, native meadow hay, alfalfa hay, corn silage, grain (barley), and sugar beets. These were evaluated on a present-condition basis and an improved-condition basis, and weighted according to the number of acres in each sub-area. Tables 5 and 6 indicate results of this analysis.

Rangeland Analysis

The range improvement phase of this part of the study was made by comparing yields of air-dry usable forage for present vegetal sites and condition classes with their potential yields. The selected period of analysis was 20 years.

The economic evaluation of the range portion of this study was made separately for each of the three sub-areas, and for the private and Federal lands within each sub-area. This was done because of differences in annual operating costs between private and Federal lands, and because of differences in vegetal sites between the sub-areas. The results of this analysis appear in Table 11.

Cost of improvements in the range portion of this study was based upon the practices and structures suggested by the Bureau of Land Management, Soil Conservation Service, and the Forest Service. Tables 12, 13, 14, and 15 show these costs.

Summary and Conclusions

Data in Table 5 indicate that suggested improvements would be profitable for individual farm or ranch operators. Profitability is an incentive to support a program that would provide suggested improvements. Data in Table 17 indicate a favorable benefit-cost ratio for each of the separate sub-areas, and for the basin in its entirety on a weighted basis.

Some observations of this analysis should be especially noted. The benefit-cost ratio of 2.40 to 1 in the lower sub-area is the highest of the three. This is attributed to the fact that the lower sub-area contains the highest portion of cropland, and per-acre returns are higher on cropland than on rangeland. Improvements on cropland, therefore, could be expected to show higher benefits per-acre than rangeland. Also, the state of development of cropland in this sub-area is such that further improvements would show high returns, and such further improvements could be made at relatively low cost, since major structures are already in place. By comparison, rangeland improvements include major structures that are basic to an improvement program. These basic improvements must be in place before further improvements can be made and benefits realized from the entire range improvement package. These basic improvements on rangeland effectively increased the per-acre cost relative to benefits, in comparison to cropland, where such basic improvements as water-storage facilities are already in place.

In the other two economic sub-areas, the benefit-cost ratios are nearer to what might be expected, with the upper sub-area having the lowest benefit-cost ratio. Possible explanations for differences are: (1) differences in the cropland potential, and (2) the relatively strong position of the upper sub-areas with regard to superior range and vegetal condition.

It should be stressed that interpretations of this analysis must be made in light of the basic assumptions discussed earlier. One of the primary assumptions to be considered is the adoption of the entire suggested program during the period of repayment. Practices must be adopted in their entirety, and in their logical order, for the estimated future income to be realized. If some practices are omitted, or if the practices are adopted out of sequence, the estimated yields and incomes could not be obtained.

References Cited

1 Neely, William V. March 1963. A Management Tool for Range Evaluation. Bulletin III, Cooperative Extension Service, Max C. Fleischmann College of Agriculture, University of Nevada, Reno, Nevada.

2 Reidhead, Richard, and Humboldt River Basin Field Party. Range Forage Production Rates and Returns to Land Per AUM of Grazing. Unpublished MS., Soil Conservation Service, USDA, Nevada.

3 Neely, William V., Agricultural Economist, Max C. Fleischmann College of Agriculture, University of Nevada.

Table 5. -- Per acre income from improvements on cropland, Humboldt River Basin Survey

Basin	Present acres	Acres after improvement	Present per acre net income	Net income after improvement	Annual cost of improvement per acre	Net annual benefits
			(dollars)	(dollars)	(dollars)	(dollars)
Upper	113,900	114,900	7.91	23.90	8.36	7.63
Middle	92,400	107,400	8.17	32.76	16.27	8.32
Lower	23,600	25,600	22.68	67.70	19.07	25.85
Total	229,900 1/	247,900	9.53 2/	32.25 2/	12.98 2/	10.47 2/

1/ Estimated total irrigated acreage for an 80 percent chance.

2/ Weighted averages. Source: University of Nevada

Table 6. -- Annual income from crops by sub-basin and total basin under present and potential conditions, Humboldt River Basin Survey

Basin	Present acres	Acres after improvement	Present net income	Potential net income	Annual cost of improvement	Net annual benefits	BC ratio
			(dollars)	(dollars)	(dollars)	(dollars)	
Upper	113,900	114,900	900,665	2,747,028	960,392	1,832,369	1.90 to 1
Middle	92,400	107,400	754,810	3,518,107	1,747.130	2,763,291	1.58 to 1
Lower	23,600	25,600	535,185	1,730,380	478,175	1,195,195	2.45 to 1
Total	229,900 1/	247,900	2,190,660	7,995,150	3,185,697	5,790,861	1.82 to 1

1/ Estimated total irrigated acreage for an 80 percent chance. Source: University of Nevada.

Table 7. -- Improvement practices and structures for cropland, Humboldt Basin

Improvement	Number	Unit	Total cost	Life years	Annual cost @ 6%
			(dollars)		(dollars)
Reservoirs (irrigation)	14	-----	12,803,600	25	1,001,626
Drainage	27,000	Acres	1,620,000	15	160,494
Land leveling	129,400	Acres	7,866,500	15	752,934
Diversions	79	-----	701,000	25	54,839
Irrigation canals	418	Miles	2,568,000	20	223,879
Irrigation ditches	1,479	Miles	969,900	15	99,861
Irrigation structures	28,270	-----	3,538,000	25	267,176
Irrigation wells and sumps	80	-----	930,400	20	63,677
Hay and pasture seeding	150,400	Acres	3,014,000	10	409,512
Total	-------	-----	33,810,700	--	3,033,998
Estimated operation and maintenance (annual)					151,699
Total annual cost					3,185,697

Table 8. -- Improvement practices and structures for cropland, upper Humboldt Basin

Improvement	Number	Unit	Total cost	Life years	Annual cost @ 6%
			(dollars)		(dollars)
Reservoirs (irrigation)	6	-----	1,421,600	25	111,212
Drainage	17,800	Acres	1,068,000	15	103,660
Land leveling	47,900	Acres	2,786,500	15	286,898
Diversions	59	-----	83,000	25	6,493
Irrigation canals	120	Miles	564,000	20	49,170
Irrigation ditches	667	Miles	783,900	15	80,710
Irrigation structures	9,630	-----	1,203,300	25	84,508
Irrigation wells and sumps	14	-----	70,400	20	6,138
Hay and pasture seeding	68,100	Acres	1,368,000	10	185,870
Total	-------	-----	9,347,700	--	914,659
Estimated operation and maintenance (annual)					45,733
Total annual cost					960,392

Source: University of Nevada and Humboldt River Basin Field Party.

Table 9. -- Improvement practices and structures for cropland, middle Humboldt Basin

Improvement	Number	Unit	Total cost	Life years	Annual cost @ 6%
			(dollars)		(dollars)
Reservoirs (irrigation)	8	-----	11,382,000	25	890,414
Drainage	1,200	Acres	72,000	15	7,413
Land leveling	55,500	Acres	3,390,000	15	349,034
Diversions	19	-----	118,000	25	9,231
Irrigation canals	292	Miles	1,194,000	20	104,093
Irrigation ditches	352	Miles	81,000	15	8,340
Irrigation structures	8,640	-----	1,085,000	25	84,880
Irrigation wells and sumps	66	-----	660,000	20	57,539
Hay and pasture seeding	56,300	Acres	1,126,000	10	152,990
Total	------	-----	19,108,000	--	1,663,934
Estimated operation and maintenance (annual)					83,196
Total annual cost					1,747,130

Table 10. -- Improvement practices and structures for cropland, lower Humboldt Basin

Improvement	Number	Unit	Total cost	Life years	Annual cost @ 6%
			(dollars)		(dollars)
Reservoirs (irrigation)	-----	-----	-----	--	-----
Drainage	8,000	Acres	480,000	15	49,421
Land leveling	26,000	Acres	1,690,000	15	117,002
Diversions	1	-----	500,000	25	39,115
Irrigation canals	6	Miles	810,000	20	70,616
Irrigation ditches	460	Miles	105,000	15	10,811
Irrigation structures	10,000	-----	1,250,000	25	97,788
Irrigation wells and sumps	------	-----	--------	--	------
Hay and pasture seeding	26,000	Acres	520,000	10	70,652
Total	------	-----	5,355,000	--	455,405
Estimated operation and maintenance (annual)					22,770
Total annual cost					478,175

Source: University of Nevada and Humboldt River Basin Field Party.

Table 11. -- Annual income from range operation under present and potential conditions on private and Federal lands, Humboldt Basin

Basin lands	Present			Potential (20 years)		
	Gross income	Operating costs	Net income	Gross income	Operating costs	Net income
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Upper						
Private	799,779	313,241	486,538	2,154,433	385,524	1,786,909
Federal	1,348,516	528,571	819,945	3,592,761	528,570	3,064,191
Subtotal	2,148,294	841,812	1,306,483	5,747,194	914,094	4,833,100
Middle						
Private	979,592	376,349	603,243	2,840,855	463,097	2,377,758
Federal	2,077,563	910,998	1,166,565	6,732,750	910,997	5,821,753
Subtotal	3,057,155	1,287,347	1,769,808	9,573,605	1,374,094	8,199,511
Lower						
Private	88,575	108,018	-19,443	331,157	132,943	198,214
Federal	105,565	115,798	-10,233	340,947	115,798	225,149
Subtotal	194,140	223,816	-29,676	672,104	248,741	423,363
Total Private	1,867,946	797,608	1,070,338	5,326,445	981,564	4,344,881
Total Federal	3,531,644	1,555,367	1,976,277	10,666,458	1,555,365	9,111,093
Total Basin	5,399,590	2,352,975	3,046,615	15,992,903	2,536,929	13,455,974

Source: University of Nevada

Table 12. -- Costs of improvement practices and structures for range lands, Humboldt Basin 1/

Item	Number	Unit	Years	Total cost	Annual operation & maintenance cost	Annual cost of practice	Total annual cost
				(dollars)	(dollars)	(dollars)	(dollars)
Fence	2,530	Miles	20	2,245,500	112,275	195,763	308,038
Cattle guards	218	-----	20	78,650	3,933	6,857	10,790
Water development	1,485	-----	20	1,720,000	95,000	149,949	244,949
Seeding	1,249,600	Acres 2/	20	9,621,920	481,097	838,839	1,319,936
Spraying	515,300	Acres	20	1,623,195	141,510	141,510	283,020
Stream channel imp.	750	Miles	20	750,000	37,500	65,385	102,885
Gully plugs	5,645	-----	20	189,000	9,490	16,477	25,967
Contour trench	15,100	Acres	20	906,000	45,300	78,985	124,285
Retention dams	46	-----	25	161,000	8,050	12,595	20,645
Contour rip	56,850	Acres	20	568,500	28,425	49,562	77,987
Check dams	625	-----	20	437,500	21,875	47,295	69,170
Weed control	5,500	Acres	Annual	18,550	------	18,550	18,550
Cabling	12,400	Acres	20	323,660	16,183	28,217	44,400
Corrals	16	-----	20	16,000	800	1,394	2,194
Brush beating	79,500	Acres	20	238,500	11,925	20,792	32,717
Livestock bridges	1	-----	20	1,500	75	130	205
Road erosion control	1,380	Miles	20	276,000	13,800	24,061	37,861
Trail erosion control	50	Miles	20	4,000	200	349	549
Access roads	355	Miles	20	284,000	14,200	24,760	38,960
Trial plots	8	-----	Annual	3,200	------	3,200	3,200
Beaver control	13	Man days	Annual	260	------	260	260
Total				19,466,935	1,041,638	1,724,930	2,766,568

1/ Fire protection costs are included in all applicable items in the table.

2/ Includes present and potential seeded acreage.

Source: University of Nevada and Humbolt River Basin Field Party.

Table 13. -- Costs of improvement practices and structures for range lands, Upper Basin of the Humboldt Basin 1/

Item	Number	Unit	Years	Total cost	Annual operation & maintenance cost	Annual cost of practice	Total annual cost
				(dollars)	(dollars)	(dollars)	(dollars)
Fence	1,135	Miles	20	1,021,500	51,075	89,054	140,129
Cattle guards	53	-----	20	29,150	1,458	2,542	4,000
Water development	685	-----	20	1,027,500	60,375	89,577	149,952
Seeding	760,500	Acres	20	5,855,850	292,793	510,513	803,306
Spraying	390,300	Acres	20	1,229,445	107,183	107,183	214,366
Channel improvement	380	Miles	20	380,000	19,000	33,128	52,128
Gully plugs	1,720	-----	20	68,000	3,440	5,928	9,368
Contour trench	4,700	Acres	20	282,000	14,100	24,585	38,685
Retention dams	19	-----	25	66,500	3,325	5,202	8,527
Contour rip	1,350	Acres	20	13,500	675	1,177	1,852
Check dams	350	-----	20	245,000	12,250	30,513	42,763
Weed control	3,500	Acres	Annual	12,250	-----	12,250	12,250
Cabling	10,600	Acres	20	275,600	13,780	24,027	37,807
Corrals	1	-----	20	1,000	50	87	137
Brush beating	40,500	Acres	20	121,500	6,075	10,592	16,667
Bridge	1	-----	20	1,500	75	130	205
Beaver control	8	Man days	Annual	160	-----	160	160
Total				10,630,455	585,654	946,648	1,532,302

1/ Fire protection costs are included in all applicable items in the table.

Source: University of Nevada and Humboldt River Basin Field Party.

Table 14. -- Costs of improvement practices and structures for range lands, Middle Basin of the Humboldt Basin 1/

Item	Number	Unit	Years	Total cost	Annual operation & maintenance cost	Annual cost of practice	Total annual cost
				(dollars)	(dollars)	(dollars)	(dollars)
Fence	1,170	Miles	20	1,053,000	52,650	91,801	144,451
Cattle guard	90	-----	20	49,500	2,475	4,315	6,790
Seeding	475,600	Acres	20	3,662,120	183,106	319,264	502,370
Water development	725	-----	20	580,000	29,000	50,564	79,564
Spraying	125,000	Acres	20	393,750	34,327	34,327	68,654
Channel improvement	300	Miles	20	300,000	15,000	26,154	41,154
Gully plugs	2,925	-----	20	117,000	5,850	10,200	16,050
Contour trench	10,400	Acres	20	624,000	31,200	54,400	85,600
Contour rip	45,500	Acres	20	455,000	22,750	39,667	62,417
Check dams	150	-----	20	105,000	5,250	9,154	14,404
Retention dams	21	-----	25	73,500	3,675	5,750	9,425
Road erosion	1,180	Miles	20	236,000	11,800	20,574	32,374
Trail erosion	50	Miles	20	4,000	200	349	549
Brush blade	36,000	Acres	20	108,000	5,400	9,415	14,815
Cabling	1,800	Acres	20	48,060	2,403	4,190	6,593
Beaver control	5	Man days	Annual	100	-----	100	100
Access roads	275	Miles	20	220,000	11,000	19,180	30,180
Weed control	1,000	Acres	Annual	3,150	-----	3,150	3,150
Trial plots	4	-----	Annual	1,600	-----	1,600	1,600
Corrals	8	-----	20	8,000	400	697	1,097
Total				8,041,780	416,486	704,851	1,121,337

1/ Fire protection costs are included in all applicable items in the table.

Source: University of Nevada and Humboldt River Basin Field Party.

Table 15. -- Costs of improvement practices and structures for range lands, Lower Basin of the Humboldt Basin 1/

Item	Number	Unit	Years	Total cost	Annual operation & maintenance cost	Annual cost of practice	Total annual cost
				(dollars)	(dollars)	(dollars)	(dollars)
Fence	190	Miles	20	171,000	8,550	14,908	23,458
Water development	75	-----	20	112,500	5,625	9,808	15,433
Seeding	13,500	Acres	20	103,950	5,198	9,062	14,260
Channel improvement	70	Miles	20	70,000	3,500	6,103	9,603
Gully plugs	1,000	-----	20	4,000	200	349	549
Contour rip	10,000	Acres	20	100,000	5,000	8,718	13,718
Retention dams	6	-----	25	21,000	1,050	1,643	2,693
Check dams	125	-----	20	87,500	4,375	7,628	12,003
Road erosion	200	Miles	20	40,000	2,000	3,487	5,487
Weed control	1,000	Acres	Annual	3,150	-----	3,150	3,150
Brush beating	3,000	Acres	20	9,000	450	785	1,235
Corrals	7	-----	20	7,000	350	610	960
Trial plots	4	-----	Annual	1,600	-----	1,600	1,600
Access roads	80	Miles	20	64,000	3,200	5,580	8,780
Total				794,700	39,498	73,430	112,929

1/ Fire protection costs are included in all applicable items in the table.

Source: University of Nevada and Humboldt River Basin Field Party.

Table 16. -- Summary of average annual return from improvements on range lands, Humboldt Basin

	Upper	Middle	Lower	Total Basin
	(dollars)	(dollars)	(dollars)	(dollars)
Potential net income (20th year)	4,833,100	8,199,511	423,363	13,455,974
Present net income	1,306,483	1,769,808	-29,676	3,046,615
Benefits (end of 20th year)	3,526,617	6,429,703	453,039	10,409,359
Average annual benefits 1/	1,763,308	3,214,851	226,520	5,204,679
Average annual cost 2/	1,532,302	1,121,337	112,929	2,766,568
Annual net benefits 3/	231,006	2,093,514	113,591	2,438,112
BC ratio	1.15 to 1	2.87 to 1	2.0 to 1	1.88 to 1

1/ Average annual net benefits is computed by dividing the increase by two

2/ Average annual cost refers to cost of improvement practices and structures. Annual operation costs have been deducted.

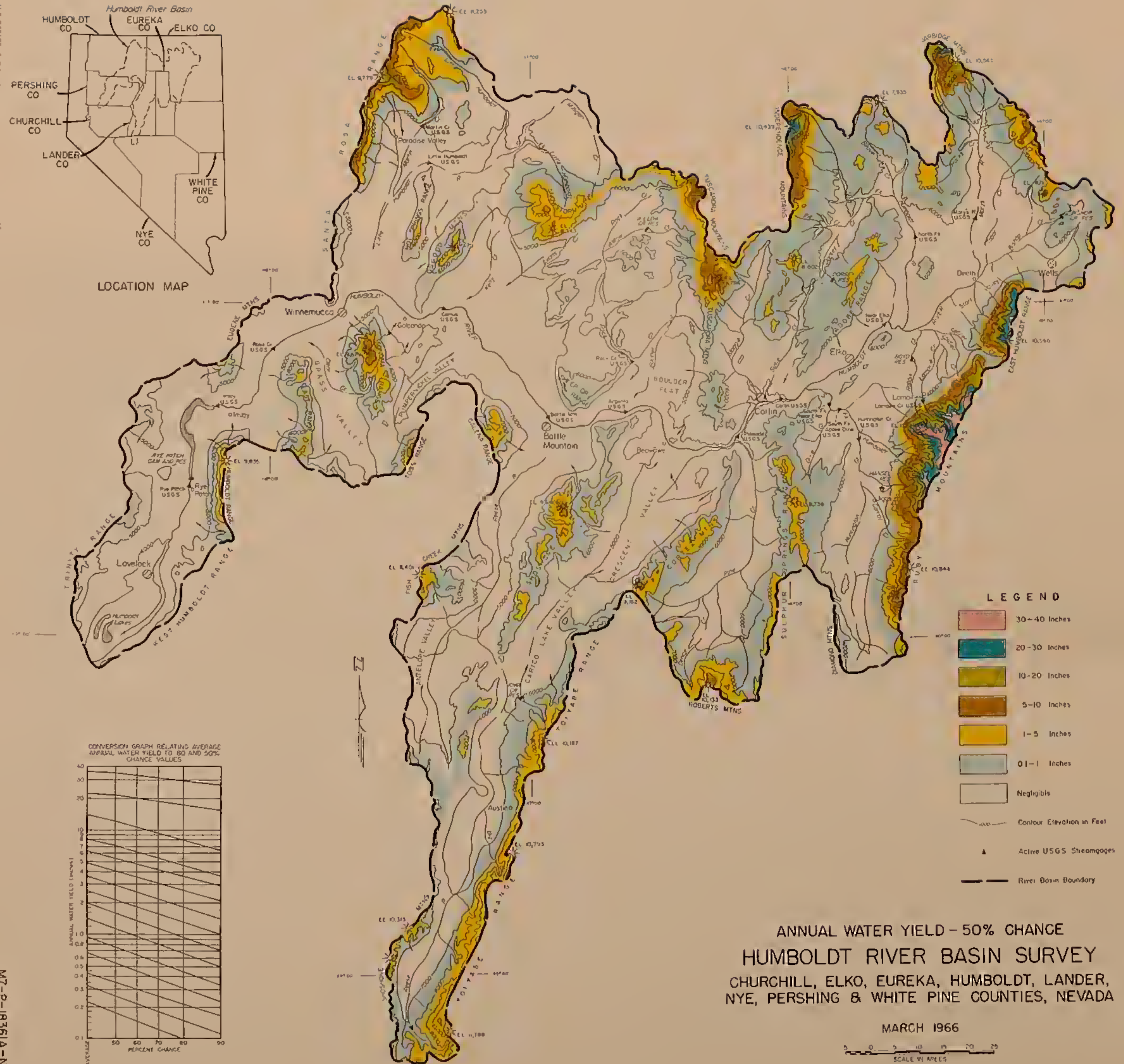
3/ Annual net benefits refer to the annual average increase of potential operations after all costs have been deducted (profit).

Source: University of Nevada

Table 17. -- Summary of economic analysis, Humboldt Basin

	Range	Crop	Total
	(dollars)	(dollars)	(dollars)
Average annual benefits from improvements			
Upper Basin	1,763,308	1,832,369	3,595,677
Middle Basin	3,214,851	2,763,297	5,978,148
Lower Basin	226,520	1,195,195	1,421,715
Total basin (weighted)	5,204,679	5,790,861	10,995,540
Average annual cost of improvements			
Upper Basin	1,532,320	960,392	2,492,694
Middle Basin	1,121,337	1,747,130	2,868,467
Lower Basin	112,929	478,175	591,104
Total basin	2,766,568	3,185,697	5,952,265
BC ratio			
Upper Basin	1.46 to 1		
Middle Basin	2.08 to 1		
Lower Basin	2.40 to 1		
Total basin	1.85 to 1		

Source: University of Nevada



ANNUAL WATER YIELD – 50% CHANCE

HUMBOLDT RIVER BASIN SURVEY

CHURCHILL, ELKO, EUREKA, HUMBOLDT, LANDER, NYE, PERSHING & WHITE PINE COUNTIES, NEVADA

MARCH 1966

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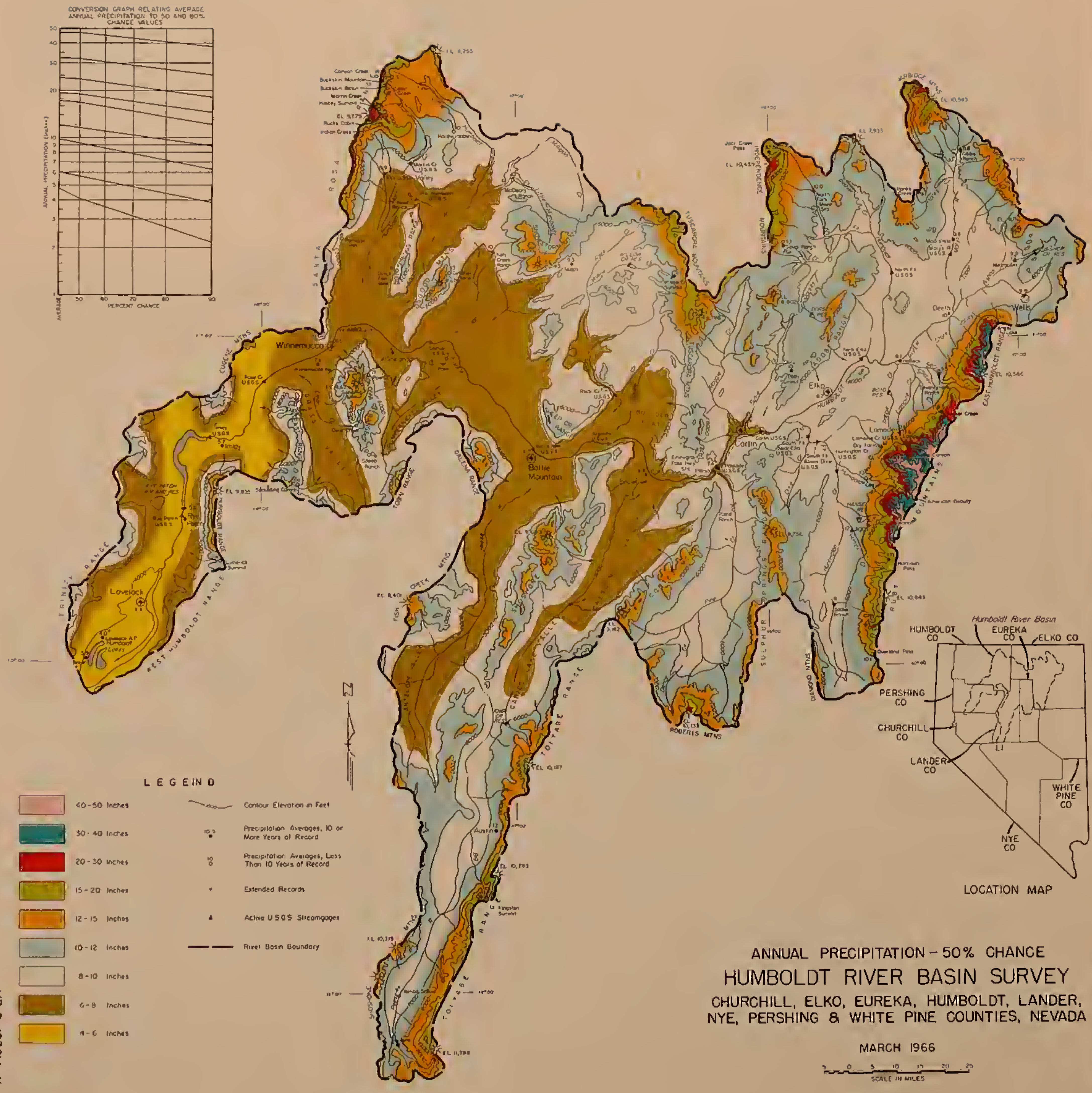

ANNUAL PRECIPITATION - 50% CHANCE

HUMBOLDT RIVER BASIN SURVEY

CHURCHILL, ELKO, EUREKA, HUMBOLDT, LANDER, NYE, PERSHING & WHITE PINE COUNTIES, NEVADA

MARCH 1966

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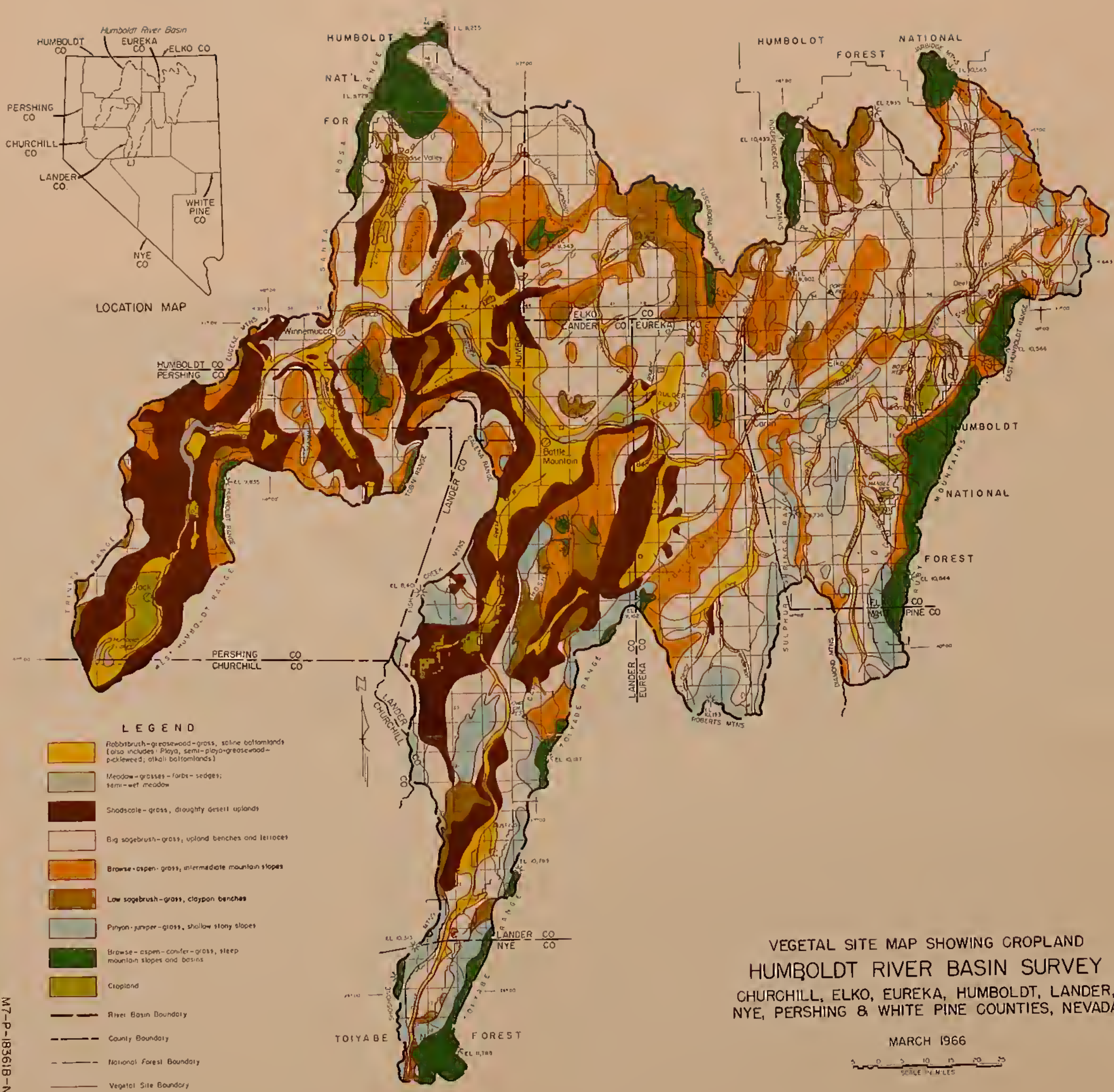


LEGEND

- Rabbitbrush–greasewood–grass, saline bottomlands (also includes: Playa, semi-playa–greasewood–pickleweed; alkali bottomlands)
- Meadow–grasses–forbs–sedges; semi-wet meadow
- Shadscale–grass, droughty desert uplands
- Big sagebrush–grass; upland benches and terraces
- Browse–aspen–grass; intermediate mountain slopes
- Low sagebrush–grass, claypan benches
- Pinyon–juniper–grass, shallow stony slopes
- Browse–aspen–conifer–grass, steep mountain slopes and basins
- Cropland
- River Basin Boundary
- County Boundary
- National Forest Boundary
- Vegetal Site Boundary

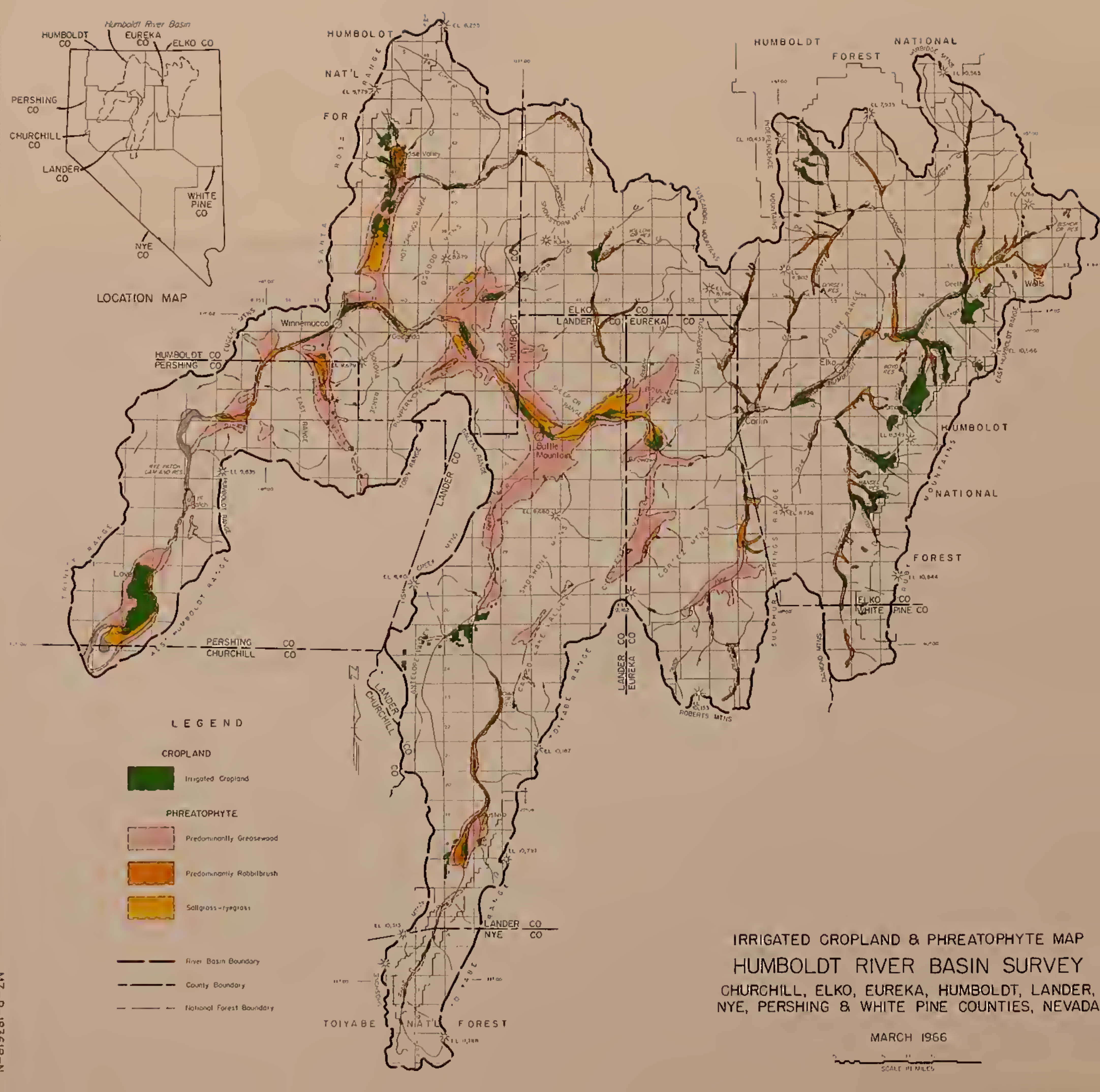
VEGETAL SITE MAP SHOWING CROPLAND

HUMBOLDT RIVER BASIN SURVEY

CHURCHILL, ELKO, EUREKA, HUMBOLDT, LANDER, NYE, PERSHING & WHITE PINE COUNTIES, NEVADA

MARCH 1966

SCALE IN MILES



IRRIGATED CROPLAND & PHREATOPHYTE MAP

HUMBOLDT RIVER BASIN SURVEY

CHURCHILL, ELKO, EUREKA, HUMBOLDT, LANDER, NYE, PERSHING & WHITE PINE COUNTIES, NEVADA

MARCH 1966

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LEGEND

SOIL AREA 1

LIGHT-COLORED SOILS OF ARID AREAS

1a Calcisol-Lithosol
1b Desert-Sierozem-Alluvial
1c Sierozem
1d Sierozem-Alluvial
1e Sierozem-Alluvial-Brown
1f Sierozem-Alluvial-Desert
1g Sierozem-Alluvial-Calcisol
1h Sierozem-Brown
1i Sierozem-Brown-Calcisol
1j Sierozem-Brown-Lithosol
1k Sierozem-Calcisol
1l Sierozem-Lithosol
1m Sierozem-Regosol
1n Sierozem-Solonetz

SOIL AREA 2

MODERATELY DARK-COLORED SOILS OF SEMI-ARID AREAS

2a Brown
2b Brown-Alluvial
2c Brown-Chestnut
2d Brown-Chestnut-Lithosol
2e Brown-Chestnut-Regosol
2f Brown-Chestnut-Sierozem
2g Brown-Lithosol-Regosol
2h Brown-Regosol-Sierozem
2i Brown-Sierozem

SOIL AREA 3

DARK-COLORED SOILS OF SEMI-ARID AREAS

3a Chestnut
3b Chestnut-Brown-Lithosol
3c Chestnut-Brown-Regosol
3d Chestnut-Lithosol-Regosol
3e Chestnut-Regosol
3f Chestnut-Regosol-Prairie

SOIL AREA 4

RECENT ALLUVIAL SOILS

4a Alluvial
4b Alluvial-Sandy Regosol
4c Alluvial-Sierozem
4d Alluvial-Solonchak-Solonetz
4e Alluvial-Solonetz

SOIL AREA 5

DARK-COLORED WET BOTTOMLAND SOILS

5a Humic Gley
5b Humic Gley-Alluvial
5c Humic Gley-Chestnut

SOIL AREA 6

IMMATURE SOILS ON UNCONSOLIDATED UPLAND MATERIALS & AEOLIAN SANDS

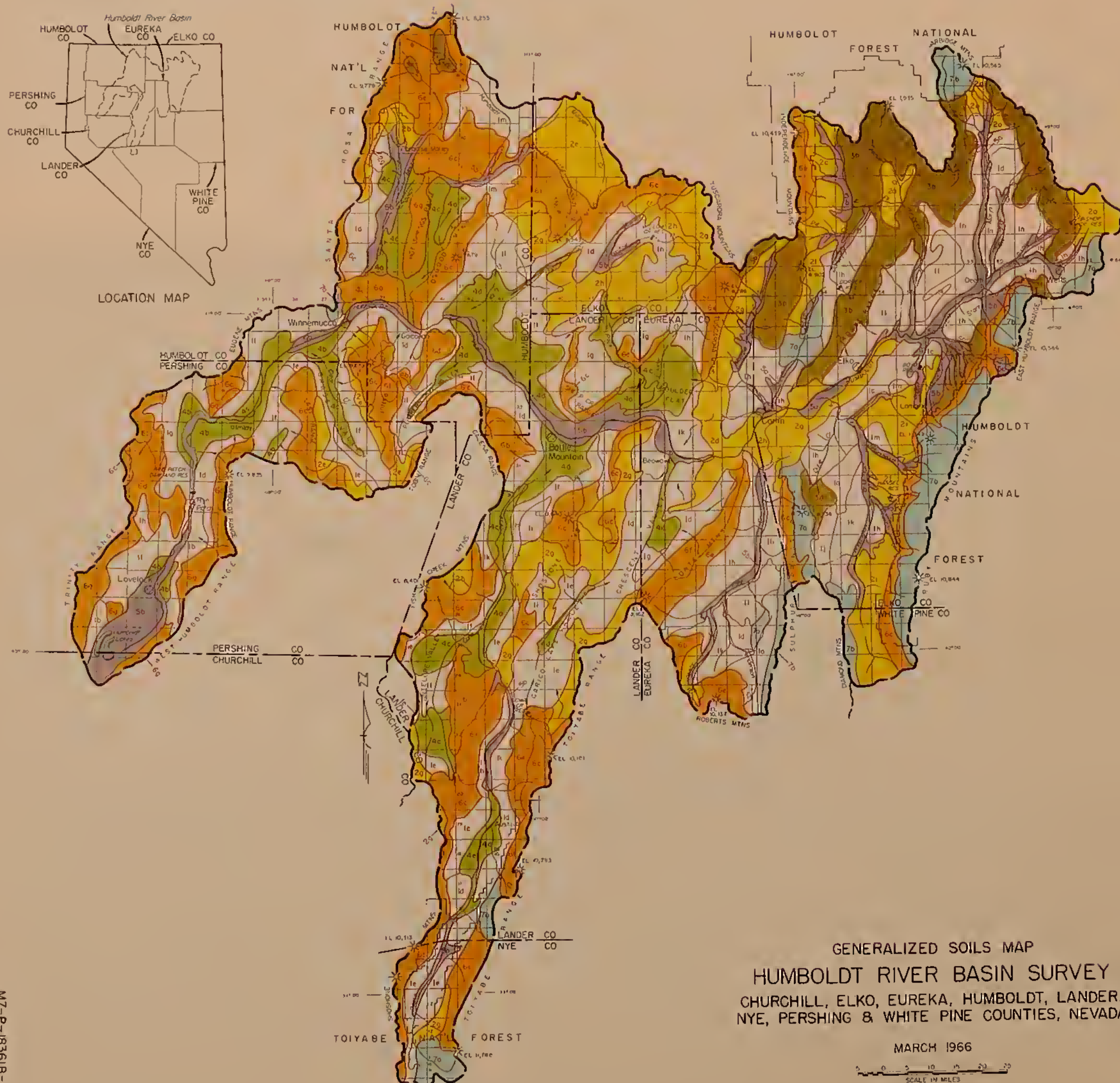
6a Sandy Regosol-Alluvial
6b Regosol-Brown-Chestnut
6c Regosol-Brown-Lithosol
6d Regosol-Brown-Sierozem
6e Regosol-Chestnut-Lithosol
6f Regosol-Lithosol
6g Regosol-Lithosol-Sierozem

SOIL AREA 7

SHALLOW SOILS ON CONSOLIDATED UPLAND MATERIAL

7a Lithosol-Brown
7b Lithosol-Regosol

River Basin Boundary
County Boundary
National Forest Boundary



LOCATION MAP

GENERALIZED SOILS MAP

HUMBOLDT RIVER BASIN SURVEY

CHURCHILL, ELKO, EUREKA, HUMBOLDT, LANDER, NYE, PERSHING & WHITE PINE COUNTIES, NEVADA

MARCH 1966

SCALE IN MILES

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

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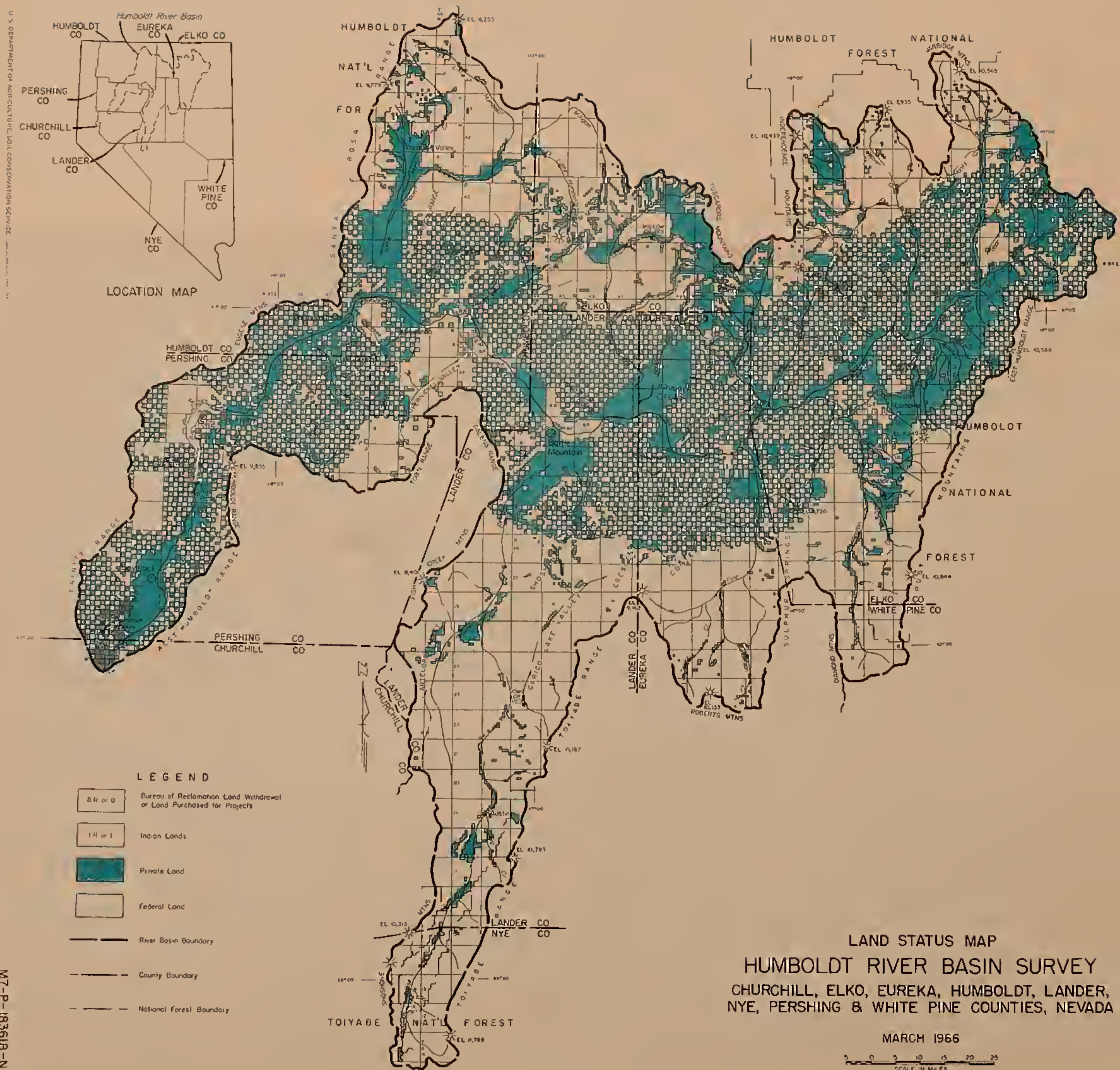

LAND STATUS MAP

HUMBOLDT RIVER BASIN SURVEY

CHURCHILL, ELKO, EUREKA, HUMBOLDT, LANDER, NYE, PERSHING & WHITE PINE COUNTIES, NEVADA

MARCH 1966

M7-P-18361B-N

Tv — Tertiary undifferentiated.

U — Undifferentiated rocks.

Mu — Mesozoic undifferentiated.

TrPP — Triassic, Permian, and Pennsylvanian; undifferentiated sedimentary and metavolcanic rocks.

Cu — Carboniferous undifferentiated; Includes Pumpernickel and Leach Formations of Carboniferous age or older. They consist mostly of chert, argillite, altered basic volcanic rocks, and quartzite.

Pu — Paleozoic undifferentiated; in northern Osgood Mountains includes Paleozoic (?) hornfels, slate, marble, chert, and metavolcanic rocks.

Pu — Dominantly Paleozoic undifferentiated; Includes shale, sandstone, carbonate, and volcanic rocks.

pCu-€(?) — preCambrian-Cambrian (?) metamorphic crystalline and granitic rocks; undifferentiated. Includes gneiss, gneissose granite, migmatite, schist, amphibolite, calc-silicate rocks, and marble.

Qa / Qg, Qb, Qs — Quaternary alluvium; Includes alluvial fan, floodplain, channel, lake, playa, gravel (Qg), sand dune (Qs), and lake bar (Qb) deposits.

QTsu — Quaternary-Tertiary sediments undifferentiated; Principally valley fill.

Ts — Tertiary sedimentary rocks; Includes silt, sand, gravel, shale, sandstone, conglomerate, tuff, limestone, marl, silicified tuff, and diatomaceous deposits.

J — Jurassic.

JTr — Jurassic-Triassic; Includes phyllite, slate, quartzite, limestone, chert, graywacke, and conglomerate.

Tr — Triassic: Includes limestone, phyllite, slate, quartzite, dolomite, shale, mudstone, sandstone, conglomerate, fanglomerate, and metamorphosed sediments.

TrP — Triassic-Permian: Includes rhyolitic volcanic rocks, tuffaceous siltstone, sandstone, and conglomerate.

P — Permian; Includes limestone, siltstone, conglomerate, sandstone, shale, chert, quartzite, rhyolitic to basic volcanic rocks, and tuffaceous deposits. At least some basic volcanic rocks are altered.

PP — Permian-Pennsylvanian; Includes limestone, sandstone, siltstone, conglomerate, shale, chert, slate, quartzite, grit, and volcanic rocks.

P — Pennsylvanian; Includes limestone, siltstone, shale, quartzite, dolomite, marl, sandstone, and conglomerate.

MP — Mississippian-Pennsylvanian; Includes conglomerate, quartzite, siltstone, limestone, and shale.

M — Mississippian; Includes andesitic volcanic rocks, shale, quartzite, and limestone.

D — Devonian; Includes limestone, shale, dolomite, and sandstone. May include some Pilot shale of Mississippian and Devonian age.

S — Silurian; Includes dolomite, shale, chert, and limestone.

O — Ordovician; Includes chert, shale, quartzite, argillite, limestone, greenstone, sandstone, siltstone, dolomite, altered andesitic lava, and pillow lava.

C — Cambrian; Includes shale, chert, limestone, quartzite, sandstone, greenstone, dolomite, grit, and pillow lava.

QTv — Quaternary-Tertiary volcanic rocks; undifferentiated, Mostly basaltic extrusives, but some welded tuff is included.

Tv — Tertiary volcanic rocks; undifferentiated flows, tuffs, breccias, and related rocks. Includes rhyolite, andesite, dacite, quartz latite, other associated rocks, and some interbedded sedimentary rocks.

Tv — Dominantly Tertiary volcanic rocks; Some areas of older consolidated rocks, such as limestone, shale, sandstone, and volcanic (?) rocks occur also.

I — Intrusive rocks; They range in age from Permian (?) through Tertiary, and include granodiorite, quartz monzonite, quartz diorite, granite, diorite, gabbro, aplite, rhyolitic and dacitic intrusives, and other associated rocks.

SOURCES USED IN COMPILING THE HUMBOLDT RIVER BASIN GEOLOGIC MAP

Bredehoeft, J. D. 1963. Hydrogeology of the lower Humboldt River Basin, Nevada. Water Resources Bull. 21, State of Nevada Dept. of Cons. and Nat. Resources in coop. with Desert Research Institute, Univ. of Nev. Plate 1.

Crosthwaite, E. G. 1963. Ground water appraisal of Antelope and Middle Reese River Valleys, Lander County, Nevada. Ground Water Resources-Reconnaissance Series Report 19, State of Nevada Dept. of Cons. and Nat. Resources, in coop. with U.S. Dept. of the Interior, Geological Survey.

Dott, R. H., Jr. 1955. Pennsylvanian stratigraphy of Elko and northern Diamond Ranges, northeastern Nevada. Am. Assoc. of Petroleum Geologists Bull. 39-11: 2211-2305.

Eakin, T. E., Moore, D. O., and D. E. Everett. 1965. Water resources appraisal of the upper Reese River Valley, Lander and Nye Counties, Nevada. Ground Water Resources-Reconnaissance Series Report 31, State of Nevada Dept. of Cons. and Nat. Resources in coop. with U.S. Dept. of the Int., Geological Survey.

Fails, T. G., Jr. 1960 Permian stratigraphy at Carlin Canyon, Elko County, Nevada. Am. Assoc. of Petroleum Geologists Bull. 44-10.

Ferguson, H. G., and S. W. Muller. 1949. Structural geology of the Hawthorne and Tonopah quadrangles, Nevada. U.S. Geological Survey Professional Paper 216.

Ferguson, H. G., Muller, S. W., and R. J. Roberts. 1951. Geology of the Mount Moses quadrangle, Nevada. U.S. Geological Survey Geologic Quadrangle Map Series.

Ferguson, H. G., Muller, S. W., and R. J. Roberts. 1951. Geology of the Winnemucca quadrangle, Nevada. U.S. Geological Survey Geologic Quadrangle Map Series.

Ferguson, H. G., Roberts, R. J., and S. W. Muller. 1952. Geology of the Golconda quadrangle, Nevada. U.S. Geological Survey Geologic Quadrangle Map Series.

Granger, A. E., Bell, M. M., Simmons, G. C., and F. Lee. 1957. Geology and mineral resources of Elko County, Nevada. Nevada Bureau of Mines, Reno, in coop. with U.S. Geological Survey. Bull. 54. 190 p.

Hotz, P. E., and R. Willden. 1961. Preliminary geologic map and sections of the Osgood Mountains quadrangle, Humboldt County, Nevada. U.S. Geological Survey Mineral Investigations Field Studies Map MF-161.

Lehner, R. E., Tagg, K. M., Bell, M. M., and R. J. Roberts. 1961. Preliminary geologic map of Eureka County, Nevada. Mineral Investigations Field Studies Map MF-178. U.S. Geological Survey in cooperation with the Nevada Bureau of Mines.

Lovejoy, D. W. 1959. Overthrust Ordovician and the Nannie's Peak Intrusive, Lone Mountain, Elko County, Nevada: Geol. Soc. America Bull. 70-5: 539-564.

Misch, P. 1960. Regional structural reconnaissance in central-northeast Nevada and some adjacent areas; observations and interpretations: guidebook to the geology of east central Nevada. Intermountain Assoc. of Petroleum Geologists and Eastern Nevada Geol. Soc. 30-31.

Regnier, Jerome. 1960. Cenozoic geology in the vicinity of Carlin, Nevada. Geol. Soc. America Bull. V. 71-8: 1189-1210.

Sharp, R. P. 1939. Basin-range structure of the Ruby-East Humboldt Range, northeastern Nevada. Bull. of Geol. Soc. of Amer. 50-8: 881-920.

Sharp, R. P. 1942. Stratigraphy and structure of the southern Ruby Mountains, Nevada. Bull. of Geol. Soc. of Amer. 53-5: 647-690.

Silberling, N. J., and R. J. Roberts. 1962. Pre-Tertiary stratigraphy and structure of northwestern Nevada. Geol. Soc. of Amer. Special Paper 72.

U.S. Geological Survey in coop. with Nevada Bureau of Mines. 1964. Mineral and water resources of Nevada. Senate Document 87.

Wallace, R. E., Tatlock, D. B., Silberling, N. J., and W. P. Irwin. 1962. Preliminary geologic map of the Unionville quadrangle, Nevada. Mineral Investigations Field Studies Map MF-245. U.S. Dept. of the Int., Geological Survey, in coop. with Nev. Bur. of Mines.

Webb, Barbara, and R. V. Wilson. 1962. Progress geologic map of Nevada, Map 16. Nev. Bur. of Mines, Reno, Nevada.

Willden, R. 1961. Preliminary geologic map of Humboldt County, Nevada. Mineral Investigations Field Studies Map MF-236. U.S. Geological Survey.

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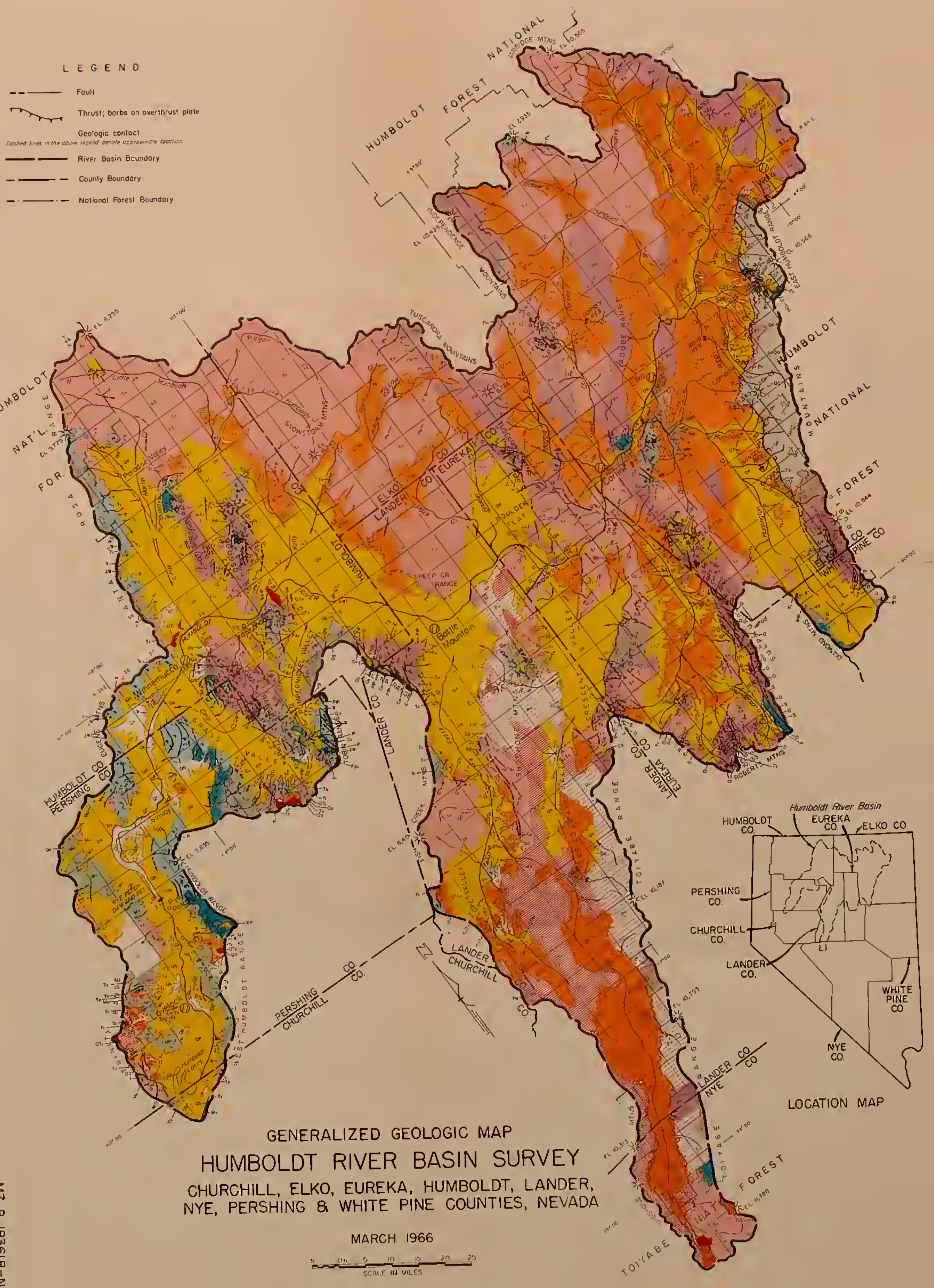

GENERALIZED GEOLOGIC MAP

HUMBOLDT RIVER BASIN SURVEY

CHURCHILL, ELKO, EUREKA, HUMBOLDT, LANDER, NYE, PERSHING & WHITE PINE COUNTIES, NEVADA

MARCH 1966

M7-P-18361B-N

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