DRAFT

ENVIRONMENTAL STUDY

Gila River from the Confluence of the Salt River Downstream to Gillespie Dam

Compiled by

Edward F. Haase
Office of Arid Lands Studies
College of Earth Sciences
University of Arizona

Submitted to
U.S. Army Engineer District
Los Angeles, California

January 1973

CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

INTRODUCTION

The purpose of this investigation was to inventory environmental and ecological elements, identify ecological problems, and to evaluate the environmental impacts resulting from a significant increase or decrease of flood flow rates in the study area.

The study area includes the Gila River floodplain and adjacent overflow areas from the confluence of the Salt and Gila Rivers west of Phoenix, Arizona, downstream to Gillespie Dam, a distance of about 36 river miles (Figure 1).

The floodplain consists primarily of native or introduced phreatophyte vegetation dominated by the exotic tamarisk (salt cedar) and by irrigated agricultural areas. Several small towns and widely scattered residences are interspersed with agriculture within, or adjacent to the study area. These include Liberty, Allenville, Buckeye, Palo Verde, and Arlington.

In the last century, the study area has changed from a natural flowing river lined with mesquite, cottonwood, willow and cattails, to a floodplain which is relatively dry except for treated sewage effluent and irrigation tailing water. Infrequent heavy flows occur after significant runoff from precipitation in the drainage basin.

The study area includes approximately 24 upstream miles of the Fred J. Weiler Green Belt Resource Conservation Area. The Greenbelt is a strip of public, private, and State lands covering an area of about 120,000 acres of Gila River floodplain from Liberty, Arizona to Texas Hill about 110 miles downstream.

Parts of the study area contain some of the most dense tamarisk stands found in the Greenbelt. These dense stands rank among the highest dove production and hunter harvest areas in the State.

Public lands in the Greenbelt totaling 62,735 acres have been classified for multiple use management since 1967 under the administration of the Bureau of Land Management in conjunction with the enforcement authority of the Arizona Department of Game and Fish. This land includes an aggregate of 6,896 acres withdrawn in 1952 under Public Land Order 1015 for use by the Arizona Game and Fish Commission in connection with the Gila River Waterfowl Area Project.

Public Greenbelt lands are withdrawn from all forms of appropriation under the public land laws with the exception of mineral leasing laws. Major public values designated by the Bureau of Land Management are nesting areas for whitewing doves, mourning doves, and song birds, public recreation, historical significance, flood and erosion control, and water conservation.

GEOLOGY

The lower Gila River Valley occurs in the Basin and Range physiographic province. The Basin and Range is characterized by mountains and valleys produced by block faulting during Laramide (late Cretaceous) and mid-Tertiary tectonic activity. The southern part of the Basin and Range, which includes the study area, has more mid-Tertiary (20-25 million years) than Laramide (70 million years) tectonic structures. Probably the prominent physiographic features of the study area were produced during the mid-Tertiary interval of mountain building.

Detailed geologic description and mapping of the study area has never been undertaken. Reconnaissance mapping was done by C.P. Ross (1922 and 1923) as part of a study of the water supply along the lower Gila River. The area was mapped by E.D. Wilson and R.T. Moore in preparation of the geologic map of Maricopa County, published in 1957 by the Arizona Bureau of Mines.

Landforms

The Gila River Valley in the study area is bounded by the White Tank Mountains to the north, the Buckeye Hills to the south, the Sierra Estrella Mountains to the southeast, and the Palo Verde Hills to the west. The study area can be divided at the mouth of the south-flowing Hassayampa River into a large eastern portion, the Buckeye Valley, and a small western portion, the Arlington Valley. The

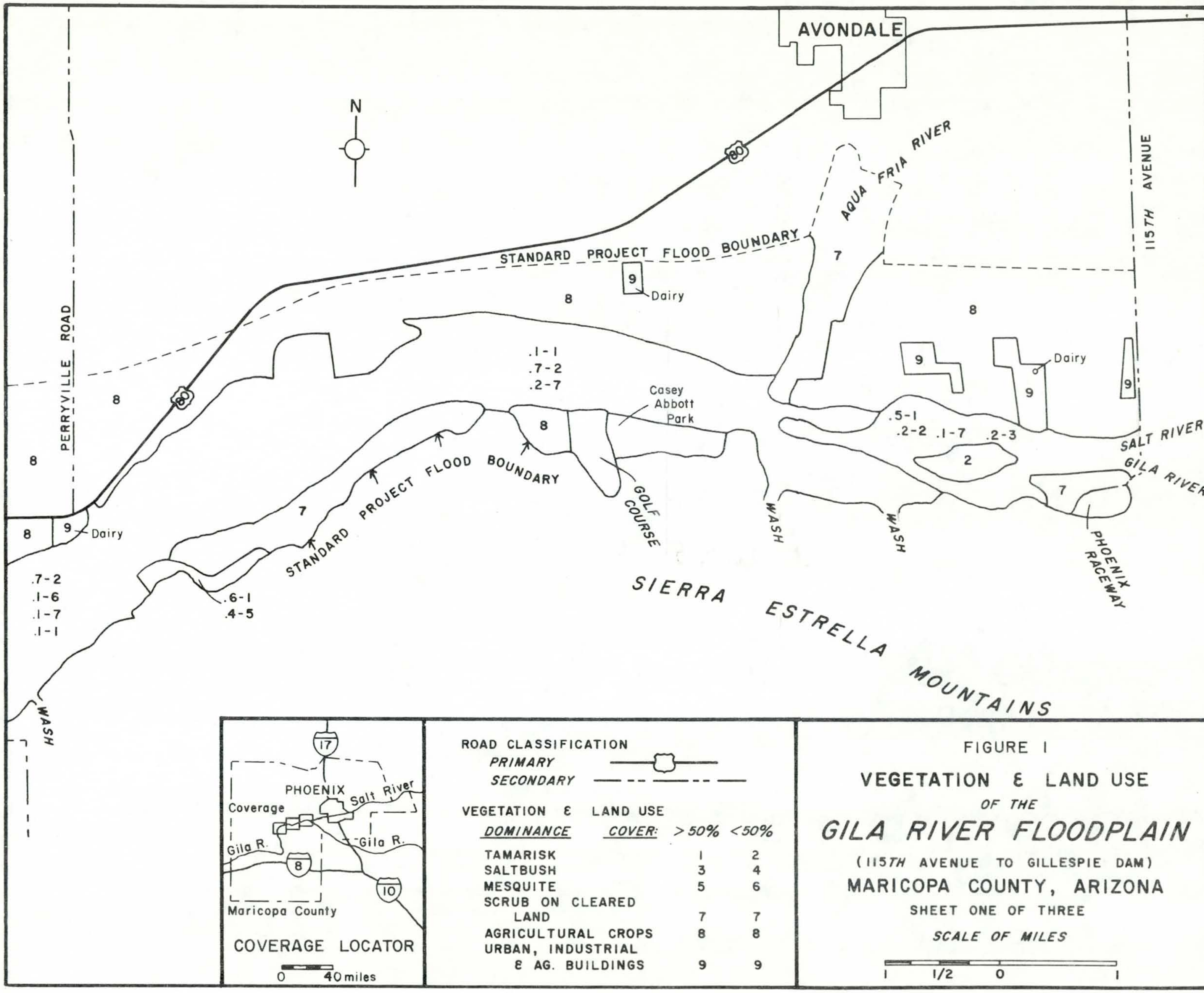


FIGURE I

VEGETATION & LAND USE

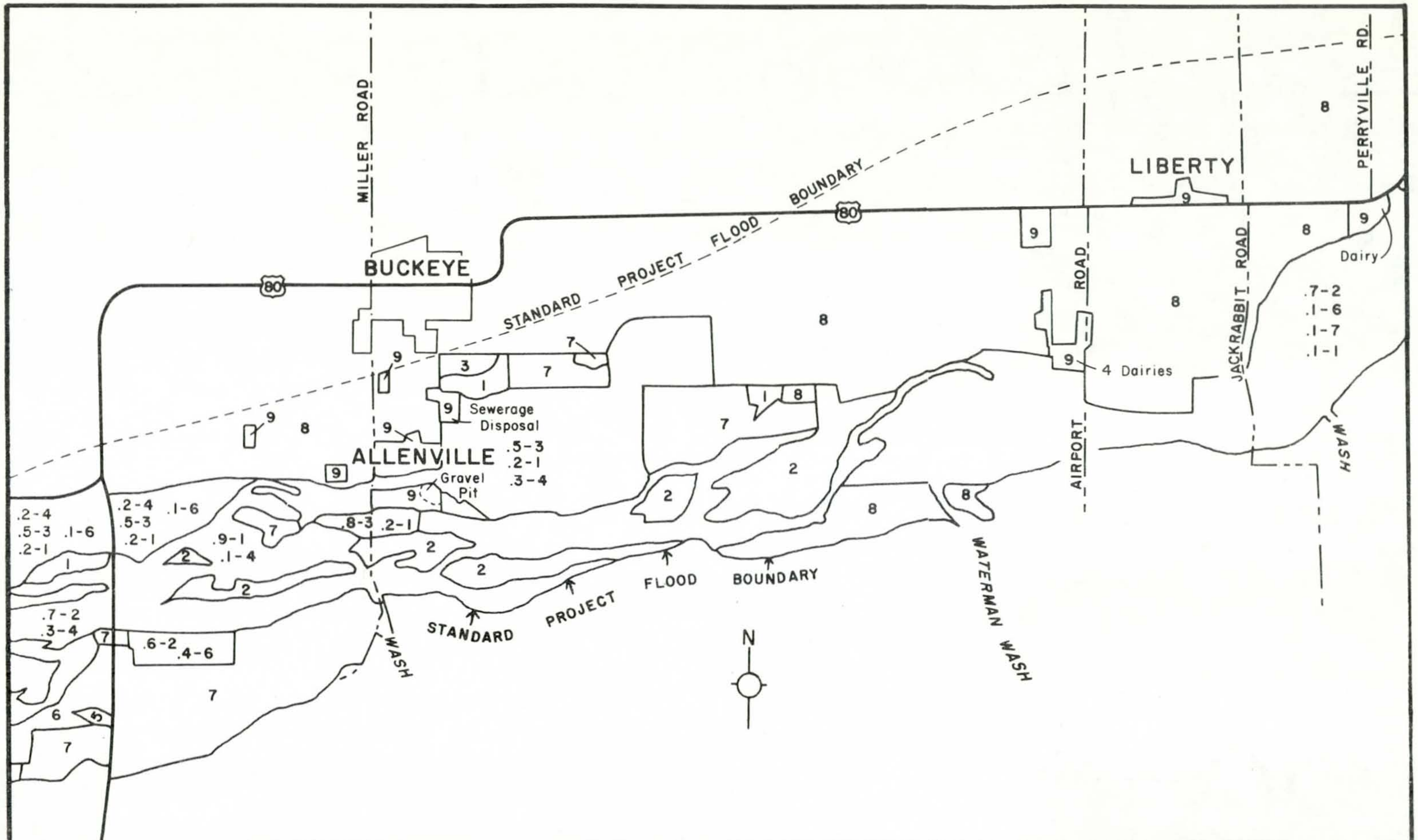
OF THE

GILA RIVER FLOODPLAIN

(115TH AVENUE TO GILLESPIE DAM)

MARICOPA COUNTY, ARIZONA

SHEET ONE OF THREE



ROAD CLASSIFICATION

PRIMARY

SECONDARY

VEGETATION & LAND USE

DOMINANCE	COVER > 50%	< 50%
TAMARISK	1	2
SALTBUSH	3	4
MESQUITE	5	6
SCRUB ON CLEARED LAND	7	7
AGRICULTURAL CROPS	8	8
URBAN, INDUSTRIAL & AG. BUILDINGS	9	9

FIGURE 1

VEGETATION & LAND USE

OF THE

GILA RIVER FLOODPLAIN

(115*TH* AVENUE TO GILLESPIE DAM)

MARICOPA COUNTY, ARIZONA

SHEET TWO OF THREE

SCALE OF MILES

1/2 0 1

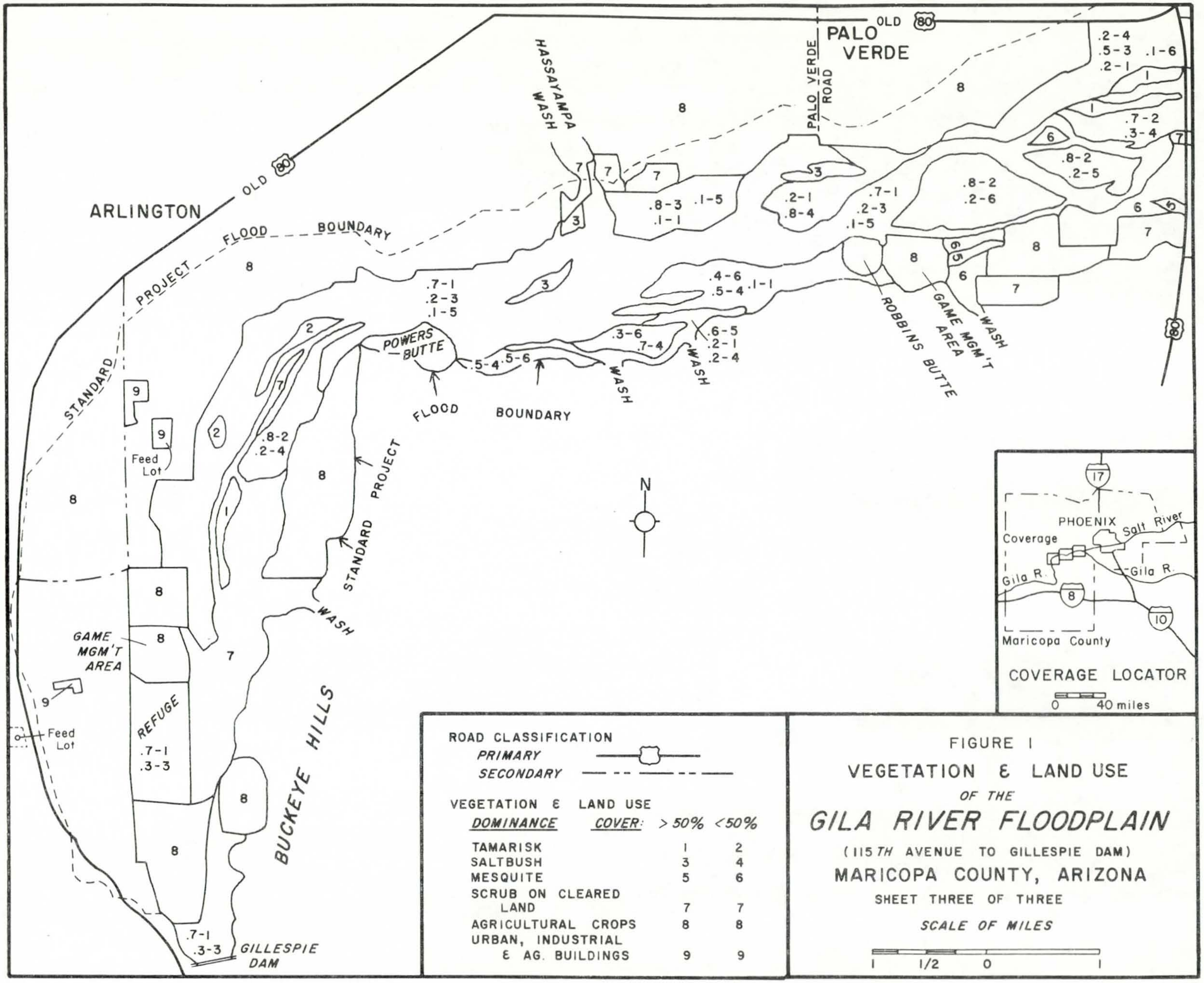


FIGURE 1
VEGETATION & LAND USE
OF THE
GILA RIVER FLOODPLAIN
(115TH AVENUE TO GILLESPIE DAM)
MARICOPA COUNTY, ARIZONA
SHEET THREE OF THREE

Buckeye Valley is elongated east-west and the Arlington Valley is elongated north-south.

The White Tank Mountains are composed primarily of igneous and metamorphic rocks termed the Basal Complex by Ross (1922). Wilson mapped Precambrian granite and gneiss, and Cretaceous granite in those mountains on the Maricopa County Geologic Map. A large and well developed alluvial plain is developed on the west side of the White Tank Mountains. The Buckeye Valley south of the White Tank Mountains is on a gently sloping alluvial plain with a slightly entrenched and relatively narrow floodplain (Figure 2). Section B-B' is a north-south profile through this area; section B-B' extends from the Palo Verde Road at Luke AFB Auxiliary Field no. 5 (intersection of secs. 16, 17,20,21, T. 1N, R. 4W) to the Buckeye Hills south of Robbin's Butte. Section B-B' shows a steeper profile on the south side of the river.

The Buckeye Hills are also composed of the Basal Complex. The east side of the Buckeye Hills consists mainly of gneissic rocks, and is an extension of gneissic rocks in the Sierra Estrella Mountains. The central part of the Buckeye Hills, including the route of Highway 80, is composed primarily of Cretaceous granite rock. The western part of the Buckeye Hills is composed primarily of Precambrian granite that extends almost to Gillespie Dam. A few isolated hills capped by late Cenozoic basalt stand out in topographic relief on the south side of the Gila River at the base of the Buckeye Hills. Power's Butte and Robbin's Butte are the most prominent of these. Gillespie Dam is bounded on both sides by late Cenozoic basalt that apparently filled the ancestral valley of the Gila River and abutted against the Precambrian granite of the Buckeye Hills. Alluvial fans are poorly developed or absent on the north and west side of the Buckeye Hills (to the Gila River). Sediments in this area are dominantly pediment gravels which were derived locally.

The Sierra Estrella Mountains are composed primarily of Precambrian gneissic rocks. A broad alluvial plain is formed on the west side of the Sierra Estrella Mountains, and a pediment surface is developed on the north side of the mountains adjacent to the Gila River (Figure 2). Section C-C' is a northwest-southeast profile from the Roosevelt canal

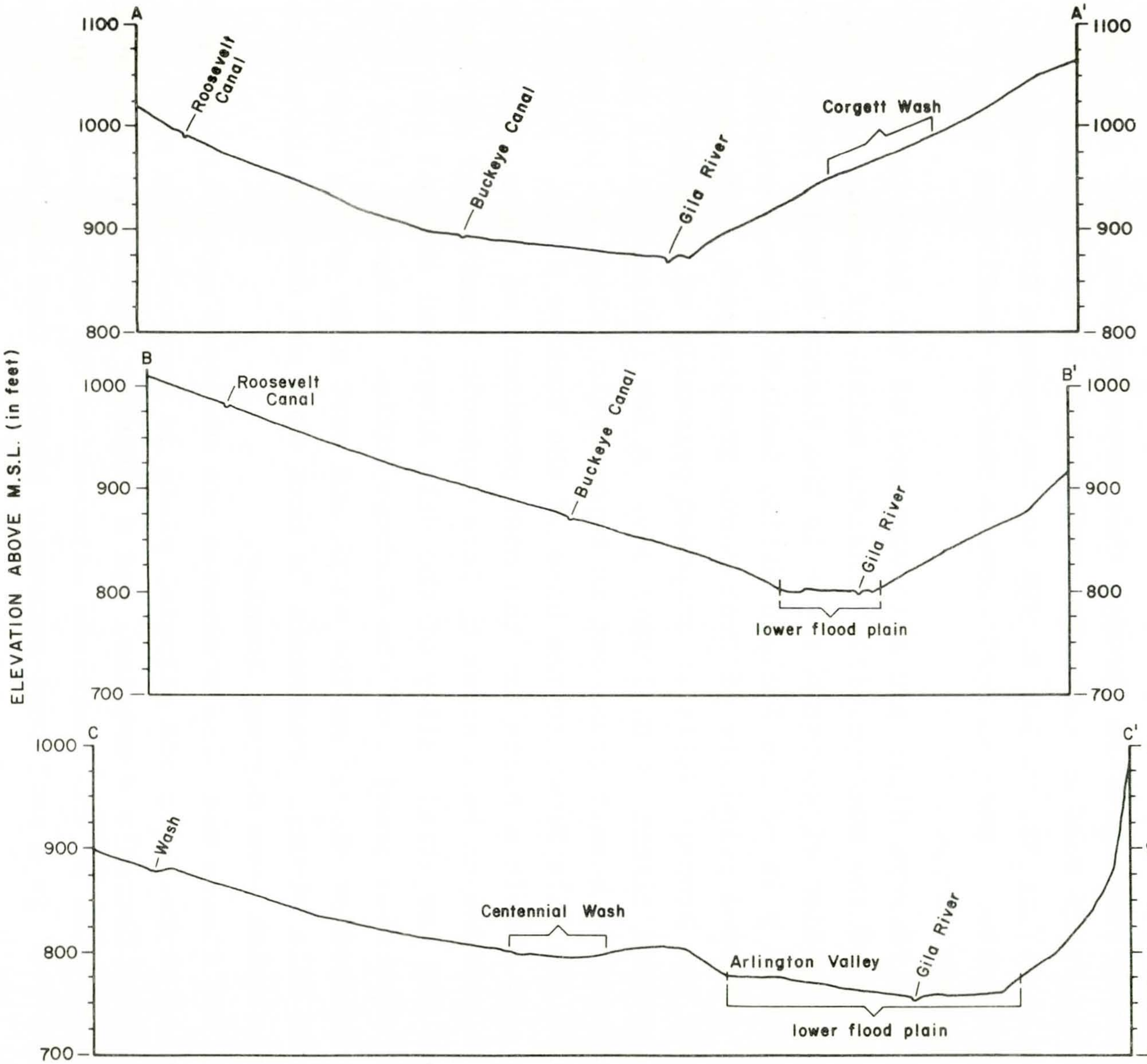


FIGURE 2
SELECTED CROSS SECTIONS
OF THE
GILA RIVER FLOODPLAIN

at the base of the White Tank Mountains (sec. 13, T. 1 N, R. 3 W) across the Gila River Valley to Rainbow Valley at the west base of the Sierra Estrella Mountains (sec. 24, T. 1 S, R. 2 W). Section C-C' shows a much steeper profile on the south side of the Gila River.

The Palo Verde Hills are composed primarily of late Cenozoic basalt which crops out in a linear trend of exposures between the Palo Verde Hills and the junction of the Hassayampa and the Gila Rivers. These basalts were probably formed during a single sequence of volcanic eruptions that altered the flow of the ancestral Gila River. They overlie floodplain sediments where the base of the basalt is exposed, except for the east side of Gillespie Dam where the basalt overlies granitic rock . A rather circular exposure of basalt located west of Hassayampa Junction was probably produced by a volcanic center in the SE 1/4 of sec. 10, T. 1 S, R. 5 W. Robbin's Butte, on the south side of the Gila River, was probably produced by a volcanic eruption, which would have temporarily dammed the Gila River. Another volcanic center surrounded by a circular exposure of basalt is located west of Gillespie Dam in the NE 1/4 of section 31, T. 2 S, R. 5 W. This volcanic eruption also dammed the Gila River and produced the side support for Gillespie Dam. A gently sloping alluvial plain is developed between the Palo Verde Hills and the Gila River. Section A-A' is an east-west profile along the line separating townships 1 and 2 south (Figure 2). The profile extends from a point south of Crag (sec. 32, T. 1 S, R. 6 W) to the Buckeye Hills at section 35, T. 1 S, R. 5 W. Section A-A' shows a steeper profile on the east side of the Gila River.

Sediments on the north and west sides of the Gila River in the study area are dominantly poorly-indurated silts and sands, characteristic of young floodplain deposits. As shown in Figure 2, these sediments slope more gently toward the River than those on the opposite side. South and east of the Gila River the sediments are coarser-grained with a dominance of pebbly sand and gravel (in lenses); these sediments are characteristic of pediment-terrace deposits. Clasts of local rock types are not commonly found north and west of the

Gila River in the study area, except for the channels of the Hassayampa and Agua Fria Rivers. Clasts of gneiss and granite that were derived from metamorphic and igneous rocks in the Sierra Estrella Mountains and the Buckeye Hills are common in sediments south and east of the Gila River. Sediments exposed near the mouth of the Agua Fria River south of Avondale (sec. 23, T. 1 N, R. 1 W) are more indurated and relatively coarser-grained than other sediments north of the Gila River. The exposure south of Avondale probably represents a stabilized sand bar formed by chemical precipitation of salts where waters of the Agua Fria and Gila Rivers mix. This local change in character of the alluvial sediments on the north side of the Gila River probably reflects a short-term and continual diagenetic process.

Floodplain sediments, capped by late Cenozoic basalt crop out in a road-cut east of Arlington (eastern half of section 22, T. 1 S, R. 5 W), on the north side of the Gila River. Poorly indurated brown sands and silts with a thickness of 13 feet are exposed below a discontinuous marlstone bed that is overlain by concretionary siltstone that varies in thickness from 4-6 feet. The basalt caprock is about 4 to 5 feet thick.

Pediment-terrace sediments overlain by reworked floodplain sediments crop out along the south bank where Jackrabbit Road crosses the Gila River (SE 1/4 of section 8, T. 1 S, R. 2 W). Irregular and uneven bedding of sand, gravel, and silt are exposed in a 15-foot-thick section. About eight feet of reworked sands, silts, and small pebbles overlie the coarser irregularly-bedded sediments.

Rock and Mineral Features

The Basal Complex of Ross (1923) is exposed in the White Tank Mountains, the Buckeye Hills, and the Sierra Estrella Mountains. The Basal Complex is interpreted to be Precambrian in age, and consists of a biotite-rich granite and an amphibolite gneiss in the study area. Both of these rock types were sampled in the Buckeye Hills. A Laramide granite intrudes the Basal Complex in the White Tank Mountains and the Buckeye Hills according to Wilson (Maricopa County Geologic Map). The Laramide granite was not sampled.

The Palo Verde Hills are composed of a late Cenozoic basalt. An extension of that volcanic rock unit was sampled on the east side of Gillespie Dam and found to be a vesicular andesite with small subangular inclusions of an orange-red baked chalcedony or altered feldspar. Volcanic rocks on the west side of Gillespie Dam were also seen to be vesicular but no rock sample was collected there. Rocks in the study area were examined only in hand specimens; no thin sections of these rocks were prepared.

Sedimentary rocks in the study area are all clastic rocks with sizes varying from clay to boulders. On the Gila floodplain north and west of the Gila River, silt-sized, poorly indurated clastic sediments are common. On the pediment slope south and east of the Gila River sands and pebbles are more common. Sediments on the pediment slope are very poorly sorted, probably having been brought to the area as sheetwash. Sediments on the north side of the Gila River were probably transported a great distance, and accumulated there as overbank fluvial deposits.

Depth of the sediments in the study area is unknown. Ross (1923) published well logs of 15 wells in the Arlington and Buckeye Valleys; four of those wells exceeded a depth of 300 feet without striking the Basal Complex.

Economic Geology

The principal economic mineral reserves in the study area are sand and gravel. Several commercial gravel pits have been developed on or adjacent to the channel of the Hassayampa River west of Buckeye. These sand and gravel pits produce construction materials utilized primarily in the metropolitan Phoenix area.

The study area has a potential for metallic mineral reserves. This potential does not seem significantly better than many other areas in central and southern Arizona. The Buckeye Mine on the east slope of Webb Mountain about six miles west of Gillespie Dam has a reported occurrence of copper and bismuth. The Blackhawk Mines on the southern margin of the White Tank Mountains about five miles northwest of Buckeye have a reported occurrence of copper, iron, and titanium. Neither of these mines have produced a significant quantity of ore.

Paleontological Items

No fossils are known from the study area. This is perplexing as fossils are found in the Salt River floodplain east of Phoenix, the Gila River floodplain near Safford, and the Gila River floodplain near Gila Bend. There is a fairly high probability of finding fossils in the study area entombed in sediments. Absence of fossils is probably related to the absence of badland erosional surfaces that would expose fossils.

Structures

No obvious structural features were observed in the study area. The sediments are flat-lying and no offsets were observed in igneous or metamorphic rocks. A few veins in igneous rocks of the Buckeye Hills tend to be oriented about N 60 W. The occurrence of these veins is too rare to be significant. The study area has a history of tectonic stability since the middle Cenozoic.

Soils

Desert soils are characteristic of the study area; they are basically azonal soils, with the development of solum very rare. The lower floodplain of the Gila River has an alluvial soil that is cultivated, producing good yields of farm produce and pasturage. The upper floodplain in the area north and west of Buckeye has been cultivated for cotton production on soils that are practically identical to the alluvial soils in the lower floodplain.

No paleosols were seen in the deeper sediments where they are exposed beneath the late Cenozoic basalt. This suggests the area was flooded repeatedly, or was otherwise unstable, during the late Cenozoic.

HYDROLOGY

Climate

The study area has a dry climate with an average annual precipitation at Buckeye of about 7.5 inches. The area is most likely to receive precipitation in July and August. During these two months an occasional late afternoon or early evening thunderstorm may produce a brief period with gusty winds, blowing sand and dust followed by an even briefer period with light rain showers. These storms are most intense over the mountain sections and are normally associated with moist, tropical air from the Gulf of Mexico. In some years unusually heavy summer rainfall, lasting for several hours and flooding much of the valley, may occur when a weak tropical disturbance moves into the area from the Gulf of California or the adjoining parts of the Pacific Ocean.

Although the area normally receives very little precipitation during the rest of the year, especially in May or June, some winters may be quite wet. As an extreme example, more than fifteen inches of rain fell in the first four months of 1905. On the other hand, only four tenths of an inch was recorded during the same period in 1903. In water year 1941, during 6 months from December to May, 12.25 inches of rain fell in the area. Winter precipitation is heaviest when the middle latitude storm track is unusually far south, so that storms enter Arizona directly from the west or southwest after picking up considerable moisture from the Pacific Ocean.

In addition to direct precipitation over the Gila River Reach under consideration, the snow cover and precipitation over the mountainous areas of the Gila, Salt and Verde Rivers play a very important role on the hydrology and water budget (Table 1) of the Gila River between Gillespie Dam and its confluence with the Salt River.

The average annual evaporation from open water surface in the Gila River Valley under consideration is in the order of 66 in. or 5.5 ac-ft. per acre.

Winter minimum temperatures are infrequently below 32° F and summer maxima are commonly over 100° F. Mean annual temperatures at Buckeye in July and January are 89° F and 51°F respectively.

Surface Water

The surface flow into the study area comes mainly from the Gila, Santa Cruz, Salt, Agua Fria, and Hassayampa Rivers, and Centennial and Waterman Washes. Due to the ephemeral nature of some of the rivers and regulation and diversion on others, the inflow is intermittent. It occurs only when excessive rainfall over the Gila River Basin produces flow in the normally dry rivers and causes spills from dams upstream from the study area. The surface water sources for the Gila River from the Salt River confluence to Gillespie Dam are:

1. Salt and Verde Rivers

The Salt River is controlled at Steward Mountain Dam, and the Verde River at Bartlett Reservoir. Release from both reservoirs is almost completely diverted above and at Granite Reef Dam. For the period 1946-61 the average annual volumes were:

U.S.G.S. Gaging Station No.		1000 Acre feet	
5020	Salt River below Stewart Mountain Dam	475.3	
5100	Verde River below Bartlett Dam	287.5	
			762.8
5110	Diversion for city of Phoenix from Salt and Verde Rivers near Fort McDowell	-30.1	
5120	Diversion from Salt River at Granite Reef Dam	-720.5	
			-750.6
	Releases minus diversions		12.2
	Treated Phoenix sewage effluent		42.0
		Total	54.2

2. Gila and Santa Cruz Rivers

For the period 1946-61, the average annual volumes were:

U.S.G.S. Gaging Station No.		1000 acre feet
4795	Gila River near Laveen	15.4
4890	Santa Cruz River near Laveen	15.0
	Total	30.4

3. Agua Fria River

The Agua Fria River is controlled by Waddell Dam (formerly Lake Pleasant Dam) at Lake Pleasant. Water released from the reservoir flows downstream 1 1/4 miles to a dam near Beardsley where it is diverted for irrigation. Thus, except for spills during floods, the water entering the Gila River is due to contributions from the drainage basin below Waddell Dam and from its tributary New River. Until recently there was no accurate way of estimating the flow reaching the Gila River from this source but, since water year 1968 gaging station No. 5139 has been installed at Avondale, measuring the Agua Fria contribution to the Gila River. Although the record is too short to have meaningful statistical parameters, the average annual flow volume of 7500 acre feet will be carried over for bookkeeping purposes.

4. Hassayampa River

The U.S. Geological Survey gaging station No. 5155 is at Box damsite near Wickenburg. The average annual runoff volume is 8000 acre feet, and it is not known what its exact contribution is to the flow of the Gila River. For bookkeeping purposes the mean annual runoff volume contribution of the Hassayampa River will be taken as 4000 acre feet.

5. Centennial Wash

U.S. Geological Survey gaging station 5175 begins records in water year 1962. Records were not obtained for some years because of shifting controls and other technical difficulties. From 7 years of record, the average annual runoff contribution of Centennial Wash is 2200 acre feet. The runoff varied between no flow in 1963 to 8800 acre feet in 1970.

6. Buckeye Canal

This canal diverts water from the north bank of the Gila River for irrigation in the Buckeye area. Records from the U.S. Geological Survey gaging station No. 5140 include waste water and flow from canals of the Salt River Project, delivered through the Buckeye feeder ditch to the Gila River channel near the mouth of the Agua Fria River. Treated Phoenix sewage effluent is also diverted into the Buckeye Canal.

In February 1960, pumpage of groundwater into the Buckeye Canal began. For the period 1946-61 the average annual diversion from the Gila River into the canal was 26,000 ac-ft. The average annual contribution of the Buckeye feeder ditch during the same period was 8500 ac-ft. The Buckeye Canal eventually discharges into the Hassayampa River.

Considering that there are minor tributaries (Waterman Wash, Salt River Tributary No. 2 at Phoenix, etc.) whose contributions are either unknown or small, and that there are minor diversions (Arlington Canal), a closer water budget is not possible (Table 1).

The high salinity of water in the Gila River below Gillespie Dam, indicates that there is considerable irrigation return flow.

Table 1. Water budget for the Gila River at Gillespie Dam.

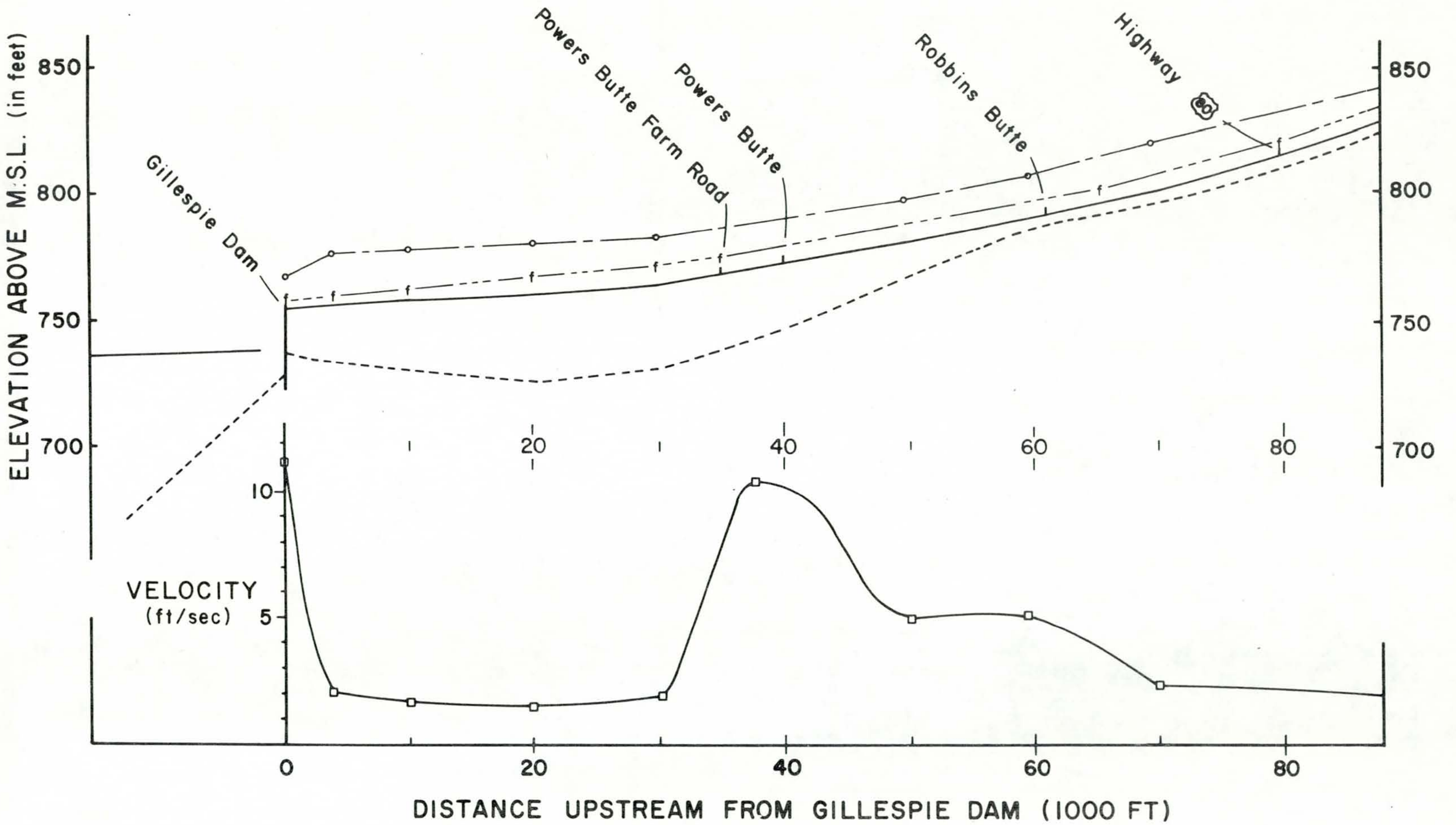
Source or Diversion		1000 acre-feet
Salt and Verde Rivers		54.2
Gila and Santa Cruz Rivers		30.4
Agua Fria River		7.5
Hassayampa River		4.0
Centennial Wash		2.2
Buckeye Feeder Ditch		8.5
	Total	106.8
Buckeye Canal Diversion		- 26.0
Enterprise Canal		- 8.6
Gila Bend Canal		- 26.2
Gila River below Gillespie Dam		- 19.7
	Total	- 80.5
Combined flow		26.3

Groundwater

Unlike the surface water, no easy separation can be made between ground water underlying the study area and that underlying the valleys of its tributaries. Groundwater elevations for spring 1972 were obtained from a map provided by the Arizona Projects Office of the U.S. Bureau of Reclamation. Tentative water contour lines showing the water table were drawn without thorough analysis of the data and are presented in Figure 3. The contours do not represent official U.S. Bureau of Reclamation or U.S. Geological Survey interpretation. Nevertheless they provide a reasonable approximation of the groundwater situation in the spring of 1972. A profile of the Gila River along its centerline is also drawn, indicating the relation of ground surface elevations and groundwater levels.

Comparison of the current groundwater contours with conditions in the spring of 1952, show that there has been a gradual decline of the groundwater table near Buckeye of nearly 20 ft. This is due to increased pumping over the years, but is not nearly as serious as conditions in other parts of the Salt and Gila River valleys. For example, between 1930 and 1972, the mean water level has declined nearly 200 feet in the Litchfield-Beardley-Marinette area.

Of particular interest is the stretch of floodplain between station 60 and station 110, where the groundwater level is on the average only 5 feet below ground level near the Gila river. This is explained by Halpenny and others. "There are places in the valley, notably in the vicinity of Tempe and near Buckeye, where the bedrock of the valley trough forms constricted passages that impede the movement of groundwater sufficiently to force it to the land surface. There are no data available from which to determine the actual width or depth of these bedrock channels. It is certain, however, that in neither locality does the constriction constitute a complete barrier to the movement of groundwater."



PROFILE LEGEND

- 300,000 cfs FLOOD BOUNDARY
- JANUARY, 1966 FLOOD BOUNDARY
- GROUND SURFACE LEVEL
- GROUNDWATER TABLE
- MEAN FLOW VELOCITY

FIGURE 3

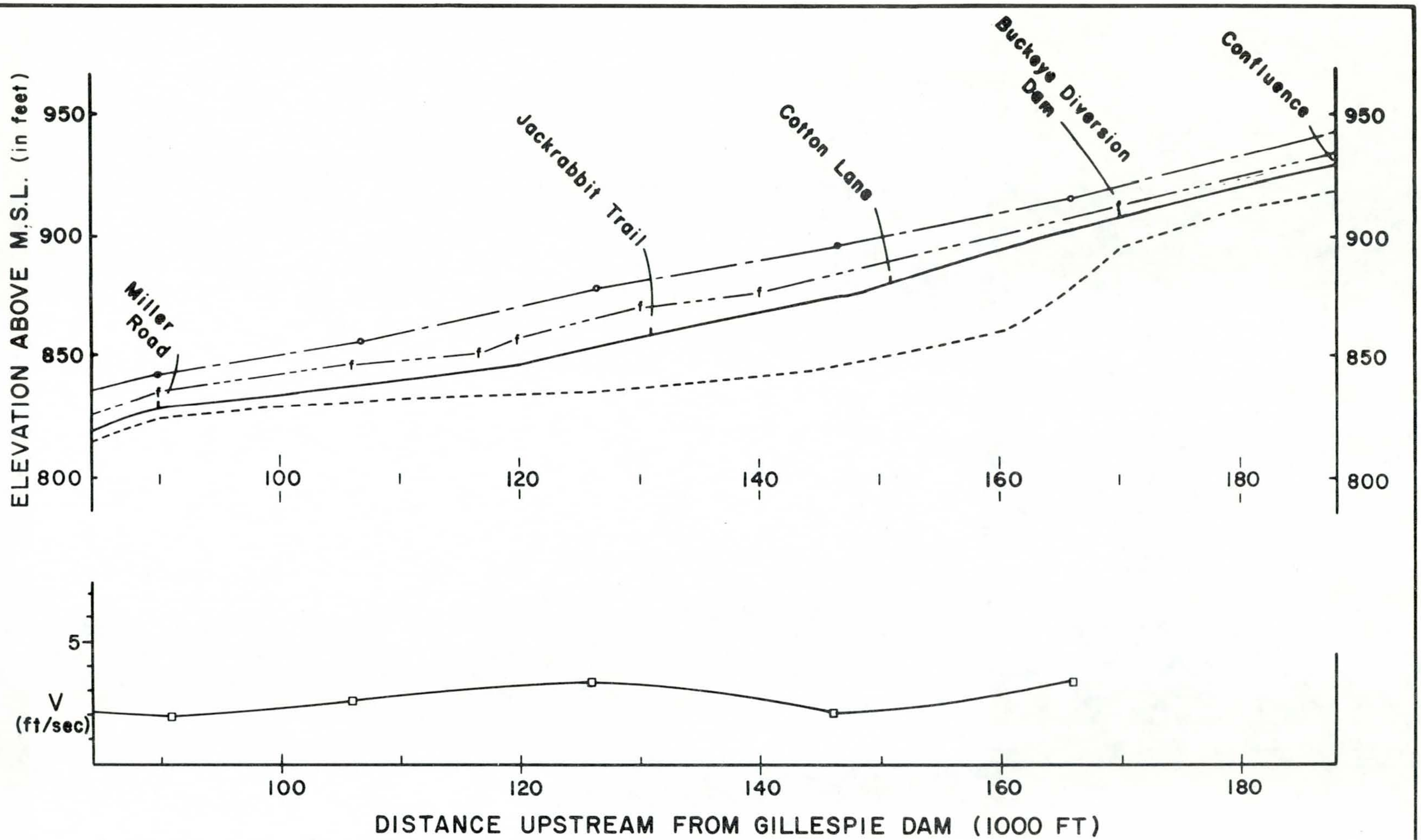
HYDROLOGIC PROFILE

OF THE

GILA RIVER FLOODPLAIN

(115*TH* AVENUE TO GILLESPIE DAM)

SHEET ONE OF TWO



PROFILE LEGEND

- 300,000 cfs FLOOD BOUNDARY
- JANUARY, 1966 FLOOD BOUNDARY
- GROUND SURFACE LEVEL
- GROUNDWATER TABLE
- MEAN FLOW VELOCITY

FIGURE 3

HYDROLOGIC PROFILE
OF THE
GILA RIVER FLOODPLAIN
(115TH AVENUE TO GILLESPIE DAM)
SHEET TWO OF TWO

There is no obvious explanation for the high groundwater levels near the confluence of the Gila and Salt Rivers. Groundwater contour levels in spring of 1952, however, indicate that the water table was at elevation 925 which is about 7 or 8 ft. higher than in the spring of 1972.

Older groundlevel contour maps show a piezometric head gradient downstream in the direction of Gillespie Dam as well as from some tributaries like the Hassayampa River and Waterman Wash toward the main channel. Although a similar trend is noticeable from the latest groundwater observations, the heavy pumping in the area has considerably distorted the picture. In some cases heavy pumping seems to have reversed the gradient from the natural direction of movement toward the cone of depression.

In Table 1, a water budget was presented indicating that a goodly portion of the flow of the Gila and the Phoenix effluent as well as waste from Salt River Project canals was diverted for irrigation. In addition, a considerable quantity of pumped water is being used for irrigation. For example, in 1962, the Buckeye Irrigation Company pumped 87,000 acre feet and diverted 10,500 acre feet of surface water to irrigate 17,400 acres. During the same year, the Arlington Canal Company diverted 600 acre feet and pumped 10,700 acre feet to irrigate 4,400 acres. There is undoubtedly a certain amount of private pumping for which the total discharge has not been determined.

In addition to withdrawal by pumping from the groundwater reservoir, there is withdrawal by evapotranspiration and underflow. Approximate values for evapotranspiration were determined by Turner and Skibitzke (1952). The underflow can of course be into or out of the basin and seepage enters the Gila River channel at numerous places between its junction with the Salt River and Gillespie Dam. This water combined with normal surface flow in the Gila River, leaves the Buckeye Valley at Gillespie Dam. Judging from the analysis of the surface water balance and the change in the concentration of total dissolved solids, effluent seepage, including irrigation return flow, furnished a considerable part of this flow while the rest was derived from floods.

Groundwater also discharges as underflow beneath Gillespie Dam. The groundwater elevations upstream and downstream from the dam show a large piezometric head difference which would cause an underflow. This has been an accepted fact, but the amount cannot be estimated.

Recharge to the groundwater reservoir in the Gila River valley between its confluence with the Salt River and Gillespie Dam occurs from the following sources:

1. Seepage from canals and irrigated lands
2. Surface flow in main channel and tributaries
3. Underflow along major tributaries
4. Rainfall

There is no direct measure of the amount attributed to seepage but various estimates indicate that 15 to 20% of the water distributed in unlined canals and used for irrigation is recharged to the groundwater reservoir.

The recharge from stream flow, which was once an important contribution to the groundwater reservoir, is now considered to be negligible. Reservoirs on the Salt, Verde and Agua Fria Rivers regulate and divert the flow for irrigation and municipal use. Hence surface flow from these rivers is very rare and occurs only during or following heavy rainfalls. Under these circumstances surface flow is due to runoff from tributary areas downstream from the dams and spill from the dams. How much of this runoff reaches the study area, and is used there as direct recharge, varies with different flow events. For example, during April 20-25, 1965, 20,000 acre feet of water was released from the Granite Reef Dam into the normally dry channel of the Salt River. At 7th Ave. the total flow was less than 100 acre feet. It has been estimated that most of the water infiltrated into the river bed at rates varying between 1.4 and 2.5 feet/day. There are indications that most of the infiltrating water probably percolated down to recharge the groundwater reservoir. Out of these 20,000 acre feet, practically no surface flow reached the Salt-Gila confluence. Thus no direct recharge resulted from this flow in the study area. On the other hand, during the December, 1965-January, 1966 floods, large parts of the study area were under water and direct recharge must have occurred. In periods of high rainfall and river flows, it is difficult to estimate from well hydrographs how much recharge is taking place, because during such periods heavy pumping for agriculture ceases, and it becomes difficult to separate the pumping effect from the recharge effect. Large recharge rates, however, should be discernible over longer periods of time.

It is very difficult to estimate the underflow reaching the groundwater reservoir in the study area and rainfall contributes little direct recharge to the groundwater reservoir.

Water Quality

The water quality index for this report is the quantity of total dissolved solids (TDS) per unit volume.

The U.S. Geological Survey monitors water quality at a number of stations in Arizona. Stations of interest in the study area are given in Table 2 together with the mean annual value of TDS in parts per million (ppm). It should be noted that while the maximum concentration of TDS in the Gila River at Kelvin was 1210 ppm and the concentration in the Salt and Verde Rivers was much less than that, the concentration in the Gila River below Gillespie Dam was substantially higher. This is due to the fact that the discharge at this point contains a considerable amount of recycled irrigation return flow. This is verified by information supplied by the Buckeye Irrigation Company.

At the Buckeye Diversion Dam the combined TDS concentration of Salt and Gila Rivers, the Salt River Project canals waste and the Tolleson and Phoenix effluents is 1400 ppm while that of the ground water pumped into the Buckeye Canal is 3600 ppm. There is a considerable amount of tailing going into the Buckeye Canal. Chemical analysis of water samples taken at Gillespie Dam indicates that the TDS content ranged from several hundred ppm during infrequent high flows to about 7000 ppm during normal flows in the 1960-65 water years. The annual weighted average for dissolved solids ranged from 1350 ppm in 1966 to 6130 ppm in 1962.

Table 2. Total dissolved solids at stations of interest in the study area in (ppm).

Station	1964	1965	1966	1967	1968	1969	1970	1971
Gila River at Kelvin	1210	1070	679	886	638	777		
Salt River below Steward Mountain Dam	693	755	447	483	508	527		
Verde River below Bartlett Dam	324	208	222	279	242	242		
Phoenix effluent from 91st St. sewage treatment plant								900
Water pumped into Buckeye Canal								3600
Gila River below Gillespie Dam	2890	5120	1350	5660	1800	4230		

There is considerable variation in the annual average salinity value of the water below Gillespie Dam. This is directly related to the runoff during the year. For example, for water year 1966, the floods of December, 1965 and January, 1966 had a diluting effect, reducing the concentration of the water during a considerable period of the year.

Although the flow in 1968 was not as large, there was a sustained period of above average river flows, with the average concentration below Gillespie Dam in the order of 700 to 900 ppm. This was instrumental in reducing the value of the average annual concentration.

VEGETATION AND LANDSCAPE

Vegetation data for an inventory of major species in the study area were obtained from field observations and from analysis of NASA aircraft photography. Color transparencies from Mission 155 photographed on January 18, 1971 at a scale of one inch per mile and color infrared transparencies from Mission 139 photographed on July 28, 1971 at a scale of two inches per mile were provided by the Arizona Regional Ecological Test Site Data Centers at the Office of Arid Lands Studies, University of Arizona in Tucson and at the U.S. Geological Survey in Phoenix.

Vegetation and land use data are presented graphically (Figurel) and in tabular form (Table 3). Map boundaries for a 300,000 cfs flood (Standard Project Flood from U.S. Army Corps of Engineers Report on Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona-1959) were provided by the Maricopa County Flood Control District.

Gila River floodplain vegetation in the study area can be classified into four communities dominated by the exotic tamarisk, mesquite, saltbush and cattail, with considerable intergradation among the first three communities in some areas. Other floodplain areas consist of scrub vegetation on land which was cleared in the past, open water, agricultural areas, and urban or industrial facilities. Outside the floodplain, upland desert communities are dominated by creosote bush

Table 3. Approximate areal coverage of vegetation types and land use in the study area within an estimated 300,000 cfs flood boundary.

TYPE		ACREAGE	
Tamarisk Community >	50% cover	5,900	
Tamarisk Community <	50% cover	5,640	
Tamarisk Community	Total		11,540
Saltbush Community >	50% cover	2,273	
Saltbush Community <	50% cover	1,223	
Saltbush Community	Total		3,496
Mesquite Community >	50% cover	526	
Mesquite Community <	50% cover	1,332	
Mesquite Community	Total		1,858
Scrub on Cleared Land			4,262
Vegetation Total			21,156
Agricultural Land			20,262
Residential, Industrial Areas and Agricultural Buildings			939
Total Area in Floodplain			42,357

or paloverde and desert wash communities are generally dominated by blue paloverde, mesquite, and ironwood. Although desert upland and desert wash communities occur in areas in which vegetation would be only slightly affected by a significant increase or decrease in flood flows, they include animal populations which also utilize habitats in the floodplain (Table 4).

Tamarisk (salt cedar) Community

Tamarisk, a phreatophyte native to Eurasia, dominates much of the floodplain vegetation in the study area (Figure 1, Table 3). However, considerable variation occurs in the density and size of individual plants. Much of the area, from the confluence of the Salt and Gila Rivers downstream to approximately the confluence with Waterman Wash, has a tamarisk dominated plant cover of less than 20 percent and includes some areas of several acres with essentially no perennial vegetation. Even the larger plants are often less than 6 feet in height and thus the area can be considered shrub dominated. Tamarisk survives here in the shrub life form by withstanding recurrent and extended drought and apparently is able to survive with little groundwater. However, more favorable plant moisture conditions undoubtedly occurred in the past, including saturated soil for several weeks when tamarisk germinated and became established.

Plotted groundwater well data in the area upstream from Waterman Wash, provided by the Bureau of Reclamation for spring 1972, indicate that depths to groundwater were more than 30 feet (Figure 3), compared to less than 4 feet in downstream areas south of Buckeye, where tamarisk occurs primarily in dense tree form.

Several narrow ribbon-like areas of tall, dense tamarisk do occur in the area from the Salt and Gila River confluence to about the Waterman Wash area. This tamarisk is generally associated with narrow channels of surface flow resulting primarily from treated sewage effluent from the City of Phoenix, discharged upstream in the Salt River outside the study area. The Arizona Department of Game and Fish has water rights to treated Phoenix sewage effluent and has constructed a dam just east of 115th Avenue at the confluence of the Salt and Gila Rivers.

Table 4. Inventory of major perennial flora of the floodplain and adjacent upland.

Key to Legend

Tamarisk (T)	Desert Upland (L)	Common (C)	Beneficial (+)
Mesquite (M)	Desert Wash (W)	Negligible (O)	Adverse (-)
Saltbush (S)	Scrub (B)	Rare (R)	
Cattail (K)	Uncommon (U)	Abundant (A)	

Common Name	Scientific Name	Major Plant Community Affiliation	Abundance	Impact of Significant Flow Increase	Impact of Significant Flow Decrease
Catclaw	Acacia greggii	TMW	U	-	-
Pickleweed	Allenrolfea occidentalis	SB	C	-	-
Four-wing saltbush	Atriplex canescens	TSL	C	-	-
Big saltbush	Atriplex lentiformis	TSB	C	-	-
				long + term	
Desert saltbush	Atriplex polycarpa	MSLB	C	-	+
Seepwillow	Baccharis glutinosa	T	U	-	-
				long + term	
Desert broom	Baccharis sarothroides	TMSWB	C	-	-
				long + term	
Bebbia	Bebbia juncea	W	U	0	0
Saguaro	Carnegiea gigantea	L	U	0	0
Desert hackberry	Celtis pallida	MW	U	-	-
Blue paloverde	Cercidium floridum	W	C	0	0
Foothill paloverde	Cercidium microphyllum	L	C	0	0
Desert willow	Chilopsis linearis	MW	U	-	-
Gray thorn	Condalia lycioides	LW	U	0	-
Hedgehog cactus	Echinocereus spp.	L	U	0	0
Brittle bush	Encelia farinosa	L	C	0	0
Mormon tea	Ephedra spp.	L	U	0	0
Barrel cactus	Ferocactus spp.	L	U	0	0
Ocotillo	Fouquieria splendens	L	U-C	0	0
Wash bursage	Franseria ambrosioides	TW	U-C	-	-

Common Name	Scientific Name	Major Plant Community Affiliation	Abundance	Impact of Significant Flow Increase	Impact of Significant Flow Decrease
Triangle bursage	Franseria deltoidea	L	C-A	0	0
White bursage	Franseria dumosa	L	C-A	0	+
Burrobrush	Hymenoclea monogyra	TW	C	-	+
Desert lavender	Hyptis emoryi	L	U	0	0
Range ratany	Krameria parvifolia	L	U-C	0	0
Creosote bush	Larrea tridentata	L	A	0	+
Desert thorn	Lycium spp.	TMSLW	U-C	-	+
Fishhook cactus	Mammillaria spp.	L	U	0	0
Tree tobacco	Nicotiana spp.	TW	U	0	-
Ironwood	Olneya tesota	MW	U-C	-	-
Cholla or prickly pear	Opuntia spp.	L	C	0	0
Mistletoe	Phoradendron spp.	MLW	U	-	-
Arrowweed	Pluchea sericea	TSB	U	-	-
				long + term	
Cottonwood	Populus fremontii	T	R	-	-
Mesquite	Prosopis juliflora	TMSW	C	-	-
Screwbean	Prosopis pubescens	TMSW	U	-	-
Willow	Salix spp.	T	R	-	-
Greasewood	Sarcobatus vermiculatus	SB	C	-	-
Bulrush	Scirpus olneyi	K	R	-	-
Jojoba	Simmondsia chinesis	L	U-C	0	0
Seepweed	Suaeda torreyana	TSB	C	-	-
				long + term	
Athel	Tamarix aphylla	T	U	-	-
Tamarisk (saltcedar)	Tamarix pentandra	TMSB	A	-	-
				long+ term	
Cattail	Typha spp.	K	R	-	-
				long +?term	

Although tamarisk is a conspicuous component of the tall and dense vegetation of the flowage area around the dam, a number of relatively tall specimens of willow, cottonwood, and mesquite also occur. Minor concentrations of desert broom, wash bursage, burrobrush, seepwillow, tree tobacco, arrowweed, desert willow, and catclaw also occur in the Tamarisk Community in general, and most of these species occur in the area of the flowage at 115th Avenue.

Except for the area just downstream from the Gila-Salt River confluence, most of the tall, dense tamarisk in the study area is found downstream from the Gila River confluence with Waterman Wash, an area which is characterized by a water table which is generally close to the soil surface (Figures 1 and 3).

The ground surface beneath dense areas of tamarisk is generally covered with silt and often with leaf liter if a flow has not occurred recently. These areas often defy human penetration and severely limit recreation potential. Although bees may utilize the flowers for honey, other animals make little use of tamarisk for food or for cover. On the other hand, some of the dense areas of tamarisk are highly productive nesting sites for whitewing doves and, to a lesser extent, mourning doves.

Tamarisk communities are components of an unstable ecosystem. They often grow to the exclusion of other species making them susceptible to ecological catastrophes such as fire, disease or significant lowering of the groundwater table. Cottonwood and willow trees are relatively rare in the study area, but can be found near the Salt-Gila River confluence. Cottonwood also occurs on Arizona Department of Game and Fish lands east of Buckeye, and a few other areas. These trees provide nesting for a variety of birds and would enhance the wildlife as well as esthetic resources of the area if their numbers increased.

Mesquite Community

Mesquite domination involves areas which are relatively small in extent (Figure 1; Table 3), although it probably was the most extensive floodplain community for the first quarter of this century.

Most of these mesquite dominated areas are found west of where U.S. 80 crosses the Gila River. Nearly all mesquite communities are found along the south side of the floodplain, particularly the area between Power's Butte and U.S. 80. The south side of the floodplain and adjacent upland areas are relatively undisturbed by man, whereas irrigated agriculture is found almost entirely on the north side of the floodplain from Power's Butte to the east end of the study area. The mesquite communities east of Power's Butte include both common and screwbean mesquite and in some places occur along with a relatively dense shrub layer of desert saltbush, an important native forage plant.

Mesquite communities include a greater variety of both plant and animal life than tamarisk communities. Various bird species may nest in mesquite and feed on the fruits of the mistletoe which often grows in the branches. The foliage and seed pods of mesquite are eaten by a variety of animals from rabbits to deer.

Saltbush Community

Although scattered saltbush shrubs are found throughout the study area, the main concentration occurs in the area around the City of Buckeye and downstream (Figure 1; Table 3). Greasewood is a conspicuous component of the Saltbush Community in the area around Buckeye and downstream slightly past the U.S. 80 crossing. Pickleweed and seepweed occur in much the same general area as greasewood. Pickleweed is often found in relatively small dense patches indicating strongly saline soil and numerous white colored surface salt accumulations are evident in the general area south of Buckeye. Common types of saltbush generally found in the study area include fourwing and big saltbush. Big saltbush is particularly dense in an area on the north side of the floodplain just downstream from the east end of the study area and in another area on the east side of the floodplain just upstream from Gillespie Dam. Greasewood and fourwing saltbush are palatable forage plants.

Cattail Marsh Community

Although the areal coverage of cattails is relatively insignificant in terms of the entire study area (see Table 3) and is probably not more than 20 acres in total, the Cattail Marsh Community with associated open water, includes hundreds of acres and has a unique and relatively rare fauna in both the study area and the regional area. The most conspicuous concentrations of cattails are found near the Arizona Department of Game and Fish Dam east of 115th Avenue and the area just downstream, particularly where the channel crosses El Mirage Road. Cattails are also conspicuous just below Gillespie Dam.

The observations of R. Roy Johnson of Prescott College over the last 20 years, attest to the fact that cattail marsh communities have given way to the encroaching tamarisk, particularly at Palo Verde Marsh, south of the town of Palo Verde and the reservoir above Gillespie Dam.

Open water surfaces are found dispersed throughout much of the study area although no large water bodies occur. Water surfaces have not been mapped for this report because of the small areas they cover, and the significant variability which may occur with the season or with patterns of runoff. However, several areas apparently have water throughout the year and support a relatively permanent fauna.

A flowage of several acres, designed to support wildlife, is maintained at the confluence of the Salt and Gila Rivers by the Arizona Department of Game and Fish. The Department has water rights to treated sewage effluent from the City of Phoenix and uses this source to maintain water levels in the pond. The dam is designed with an earthen plug which ruptures and drains the pond in the event of flood flows from upstream. The earthen plug is then replaced after each major flow which removes it. An apparently permanent flow continues downstream from the Salt and Gila River confluence, fed largely by treated Phoenix sewage effluent. Although some of this water is diverted at Buckeye Diversion Dam for irrigation purposes (Table 1), some water, for at least part of the year, continues downstream on the Gila River.

Surface flow diminishes noticeably and may disappear farther downstream from the Buckeye Diversion Dam, but significantly increases again west of the Waterman Wash confluence where the South Extension of the Buckeye Canal enters the Gila River Channel.

Several ponds occur in the floodplain south of Buckeye and those just east of Miller Road are associated with gravel pit operations. Surface water flow continues from the Buckeye area downstream to Gillespie Dam and beyond and may be continuous throughout the year although that observation has not been made. Ponds of several acres exist for at least part of the year in the Arlington Wildlife Area. These ponds are used extensively by waterfowl.

Other Areas

Scrub vegetation occurs on the floodplain throughout the study area on lands which were apparently cleared primarily for agricultural use (Figure 1; Table 3). Other areas have apparently been burned in the recent past. Scrub vegetation is dominated by seepweed, tamarisk shrubs, and to a lesser extent, saltbush and mesquite shrubs. Some relatively small areas may be dominated by arrowweed or pickleweed.

Agricultural land use predominates in the study area, but is generally limited to locations north of the Gila River from the upstream end of the study area to where the river turns south at Power's Butte. Land used for agriculture occurs on both sides of the Gila River from Power's Butte to Gillespie Dam although development is more extensive to the west.

Upland desert vegetation generally occurs outside the area subject to significant flooding, and has been subjected to relatively little disturbance by man. It is found adjacent to the study area almost entirely on the south side of the floodplain from the Salt and Gila River confluence downstream to Power's Butte.

The relatively flat outwash plains are dominated by creosotebush, white or triangle leaf bursage, or desert saltbush. Steep alluvial slopes and areas with coarse topography are dominated by foothill paloverde.

Desert wash vegetation is interspersed with desert upland vegetation where rills and washes dissect the topography. Dominant trees include blue palo verde, mesquite, and ironwood.

ANIMAL LIFE

Avifauna

Data for an inventory of birds in the study area (Table 5) and attendant remarks (Appendix A), were primarily taken from an unpublished manuscript at Prescott College by R. Roy Johnson, James M. Simpson and James R. Werner based on observations made in the 1950's and 1960's. Additional information was provided by Johnson, Amadeo M. Rea, and Stephen M. Russell.

Recent quantitative data on bird numbers and areal extent of whitewing dove nesting habitats were provided by Dennis Wigal from information to be included in Arizona Game and Fish Department Special Report No. 2, 1972. He estimates a total of 6,500 acres of tamarisk and 200 acres of mesquite whitewing nesting habitat in the study area. Whitewing nesting data from Miller Road to Gillespie Dam indicate a nest density of 12.8 per acre, a minimum population level of 95,000 and an annual production of 49,000 whitewings.

The major, if not the only, bird species which may have benefited from the invasion of tamarisk in the floodplain are whitewing and mourning doves. Whitewings apparently outnumber mourning doves and in some areas it may be by as much as two to one. Tamarisk as well as cattails provide winter roosts for great numbers of red-winged blackbirds, yellow-headed blackbirds and starlings. Flocks of these birds have been estimated in the hundreds of thousands.

Cattail marsh and open water provide excellent habitat for a variety of breeding and migrating waterfowl, wading birds, and shorebirds. The following species breed in the study area marshes:

- Pied-billed Grebe
- Least Bittern
- American Bittern
- Ruddy Duck
- Virginia Rail
- Sora
- Common Gallinule
- American Coot
- Long-billed Marsh Wren
- Yellowthroat
- Song Sparrow

Table 5. Inventory of birds in the study area.

Key to Legend

C = Common	F = Fall	V = Vistant	- = Species which will be lost or greatly reduced in number if water and/or riparian vegetation were not present.
I = Irregular	R = Resident	W = Winter	
U = Uncommon	Sp = Spring	* = Breeding	
A = Accidental	S = Summer	** = Predicted	
		R = Resident	

COMMON NAME	SCIENTIFIC NAME	REMARKS (See also Appendix A)	
Eared Grebe	Podiceps caspicus	- UWV	
Pied-billed Grebe	Podilymbus podiceps	*- UR	
White Pelican	Pelècanus erythrorhynchos	- IV	
Double-crested Cormorant	Phalacrocorax auritus	- USpFT	
Great Blue Heron	Ardea herodias	- CT & WV 1	
Green Heron	Butorides virescens	*- CR	
Common Egret	Casmerodius albus	- USpFT	
Snowy Egret	Leucophoyx thula	- CSpFT	
Black-crowned Night Heron	Nycticorax nycticorax	- UT	
Least Bittern	Ixobrychus exilis	*- USR	2
American Bittern	Botaurus lentiginosus	- UT	3
Wood Ibis	Mycteria americana	- IV	
White-faced Ibis	Plegadis chihi	- CSpFT	
Roseate Spoonbill	Ajaia ajaja	- A	4
Canada Goose	Branta canadensis	- CWV	
Snow Goose	Chen hyperborea	- UWV	
Black-bellied Tree Duck	Dendrocygna autumnalis	- USR	
Mallard	Anas platyrynchos	- CWV	
Gadwall	Anas strepera	-** UWV	
Pintail	Anas Acuta	- CWV	
Green-winged Teal	Anas carolinensis	- CWV	
Blue-winged Teal	Anas discors	- USpFT	
Cinnamon Teal	Anas crecca	- CWV	
American Widgeon	Mareca americana	- CWV	
Shoveler	Spatula clypeata	- CWV	
Wood Duck	Aix sponsa	- A	5

COMMON NAME	SCIENTIFIC NAME	REMARKS	
Redhead	*Aythya americana*	- UWV	
Ring-necked Duck	*Aythya collaris*	-**	
Canvasback	*Aythya valisineria*	- UWV	
Lesser Scaup	*Aythya affinis*	- UWV	
Bufflehead	*Bucephala albeola*	- UWV	
Oldsquaw	*Clangula hyemalis*	- A	6
Ruddy Duck	*Oxyura jamaicensis*	-* UR	
Common Merganser	*Mergus Merganser*	- UWV	
Red-breasted Merganser	*Mergus serrator*	- USpFT	
Turkey vulture	*Cathartes aura*	* UR	
Black vulture	*Coragyps atratus*	IV	
Goshawk	*Accipiter gentilis*	A	7
Sharp-shinned Hawk	*Accipiter striatus*	- UWV	
Cooper's Hawk	*Accipiter cooperii*	- UWV	8
Red-tailed Hawk	*Buteo jamaicensis*	* CR	
Swainson's Hawk	*Buteo swainsoni*	USpT	
Rough-legged Hawk	*Buteo lagapus*	A	9
Harris'Hawk	*Parabuteo uniciotus*	?	10
Marsh Hawk	*Circus cyaneus*	CWV	
Osprey	*Pandion haliaetus*	- USpFT	
Prairie Falcon	*Falco mexicanus*	* UR	
Peregrine Falcon	*Falco peregrinus*	- UWV	
Pigeon Hawk	*Falco columbarius*	UT	
Sparrow Hawk	*Falco sparverius*	* CR	
Gambel's Quail	*Lophortyx gambelii*	* CR	
Sandhill Crane	*Grus canadensis*	- IWV	
Clapper Rail (endangered species)	*Rallus longirostris*	-* USR?	11
Virginia Rail	*Rallus limicola*	-* UR	12
Sora	*Porzana carolina*	-* UWV(R?)	13
Common Gallinule	*Gallinula chloropus*	-* CR	14
American Coot	*Fulica americana*	-* CR	
Killdeer	*Charadrius vociferus*	-* CR	
Common Snipe	*Capella gallinago*	- CWV	
Spotted Sanderpiper	*Actitis macularia*	- CWV	
Solitary Sandpiper	*Tringa solitaria*	- USpFT	
Greater Yellowlegs	*Totanus melanoleucus*	- UWV	
Lesser Yellowlegs	*Totanus flavipes*	- USpFT	

COMMON NAME	SCIENTIFIC NAME		REMARKS	
Pectoral Sanderpiper	Erolia melanotos	-	UFT	
Bairds Sandpiper	Erolia bairdii	-	UFT	
Least Sandpiper	Erolia minutilla	-	CWV	
Long-billed Dowitcher	Limnodromus scolopaceus	-	CSpFT	
Stilt Sandpiper	Micropalama himantopus	-	A	15
Western Sandpiper	Ereunetes mauri	-	USpFT	
American Avocet	Recurvirostra americana	-	USpFT	16
Black-necked Stilt	Himantopus mexicanus	-*	USR	17
Wilson's Phalarope	Steganopus tricolor	-	CSpFT	
Northern Phalarope	Lobipes lobatus	-	USpFT	18
Ring-billed Gull	Larus delawarensis	-**		
Bonaparte's Gull	Larus philadelphia	-	USpFT	19
Common Tern	Sterna hirundo	-	A	20
White-winged Dove	Zenaida asiatica	-*	CSR	21
Mourning Dove	Zenaidura macroura	-*	CR	22
Ground Dove	Columbigallina passerina	-*	UR	
Inca Dove	Scardafella inca	-*	CR	
Yellow-billed Cuckoo	Coccyzus americanus	-*	USR	
Roadrunner	Geococcyx californianus	*	CR	
Barn Owl	Tyto alba	-**		
Screech Owl	Otus asio	-*?	R?	23
Great Horned Owl	Bubo virginianus	-**		
Burrowing Owl	Speotyto cunicularia	*	UR	
Lesser Nighthawk	Chordeiles acutipennis	*	CSR	
White-throated Swift	Aeronautes saxatalis		UIV	
Black-chinned Hummingbird	Archilochus alexandri	-*	CSR	
Costa's Hummingbird	Calypte costae	*	CSR	
Anna's Hummingbird	Calypte anna	-*?	U?	24
Rufous Hummingbird	Salasphorus rufus	-	UFT	
Belted Kingfisher	Megaceryle alcyon	-	UWV	
Yellow-shafted Flicker	Colaptes auratus		A	25
Red-shafted Flicker	Colaptes cafer	-	CWV	
Gilded Flicker	Colaptes chrysoides	-*	UR	
Gila Woodpecker	Centurus uropygialis	-*	CR	
Ladder-backed Woodpecker	Dendrocopos scalaris	-*	UR	26

COMMON NAME	SCIENTIFIC NAME		REMARKS	
Western Kingbird	*Tyrannus verticalis*	-*	CSR	
Cassin's Kingbird	*Tyrannus vociferans*	-	UT	27
Wied's Crested Flycatcher	*Myiarchus tyrannulus*	-*	USR	
Ash-throated Flycatcher	*Myiarchus cinerascens*	-*	CSR	
Black Phoebe	*Sayornis nigricans*	-*	UR	
Say's Phoebe	*Sayornis saya*		UWV	
Empidonax Flycatchers	*Empidonax spp.*	-		28
Western Wood Pewee	*Contopus sordidulus*	-	CSpFT	
Vermilion Flycatcher	*Pyrocephalus rubinus*	-	UWV	
Horned Lark	*Eremophila alpestris*		CWV	
Violet-green Swallow	*Tachycineta thalassina*		CSpFT	
Tree Swallow	*Iridoprocne bicolor*		USpFT	
Rough-winged Swallow	*Stelgidopteryx ruficollis*	-*	USR	
Barn Swallow	*Hirundo rustica*		CSpFT	
Cliff Swallow	*Petrochelidon pyrrhonota*	-*	USR	
Purple Martin	*Progne subis*		UT	29
Scrub Jay	*Aphelocoma coerulescens*		IWV	
Common Raven	*Corvus corax*	*	UR	30
Verdin	*Auriparus flaviceps*	*	CR	
House Wren	*Troglodytes aedon*	-	UWV	
Bewick's Wren	*Thryomanes bewickii*	-	UWV	
Cactus Wren	*Campylorhynchus brunneicapillus*	*	CR	
Long-billed Marsh Wren	*Telmatodytes palustns*	-*	UR	31
Rock Wren	*Salpinctes obsoletus*	*	UR	
Mockingbird	*Mimus polyglottos*	-*	UR	
Bendire's Thrasher	*Toxostoma bendirei*	*	UR	
Curve-billed Thrasher	*Toxostoma curvirostre*	*	CR	
Crissal Thrasher	*Toxostoma dorsale*	-*	CR	
Sage Thrasher	*Oreoscoptes montanus*		IWV	
Robin	*Turdus migratorius*	-	IWV	
Hermit Thrush	*Hylocichla guttata*	-	WV?	32
Western Bluebird	*Sialia mexicana*	-	IWV	
Mountain Bluebird	*Sialia currucoides*		IWV	
Black-tailed Gnatcatcher	*Polilptila melanura*	-*	UR	33
Ruby-crowned Kinglet	*Regulus calendula*	-	CWV	
Water Pipit	*Anthus spinoletta*	-	CWV	

COMMON NAME	SCIENTIFIC NAME	REMARKS	
Phainopepla	*Phainopepla nitens*	*? SR?	34
Loggerhead Shrike	*Lanius ludovicianus*	* UR	
Starling	*Sturnus vulgaris*	-* CR	35
Bell's Vireo	*Vireo belli*	-* USR	36
Solitary Vireo	*Vireo solitarius*	-* USpFT	
Warbling Vireo	*Vireo gilvus*	- USpFT	
Orange-crowned Warbler	*Vermivora celata*	- UWV	
Nashville Warbler	*Vermivora ruficapilla*	- USpFT	
Lucy's Warbler	*Vermivora luciae*	-* USR	37
Yellow Warbler	*Dendroica petechia*	-* USR	
Audubon's Warbler	*Dendroica auduboni*	- CWV	
Black-throated Gray Warbler	*Dendroica nigrescens*	- USpFT	
Townsend's Warbler	*Dendroica townsendi*	- USpFT	
MacGillivray's Warbler	*Oporornis tolmiei*	- CSpFT	
Yellowthroat	*Geothlypis trichas*	-* USR	
Yellow-breasted Chat	*Icteria virens*	-* CSR	
Wilson's Warbler	*Wilsonia pusilla*	- CSpFT	
English Sparrow	*Passer domesticus*	-* CR	
Eastern Meadowlark	*Sturnella magna*	- UWV	38
Western Meadowlark	*Sturnella neglecta*	-* CR	
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	CR -*	39
Red-winged Blackbird	*Agelaius phoeniceus*	-* CR	40
Hooded Oriole	*Icterus cucullatus*	-* USR	41
Bullock's Oriole	*Icterus bullockii*	-* USR	41 & 43
Brewer's Blackbird	*Euphagus cyanocephalus*	- CWV	
Boat-tailed Grackle	*Cassidix mexicanus*	-* UR	42
Brown-headed Cowbird	*Molothrus ater*	-* CR	43
Bronzed Cowbird	*Tangavius aeneus*	-* SR	41
Western Tanager	*Piranga ludoviciana*	CSpFT	
Cardinal	*Richmondena cardinalis*	-* CR	
Black-headed Grosbeak	*Pheucticus melanocephalus*	- CSpFT	
Blue Grosbeak	*Guiraca caerulea*	-* CSR	
Lazuli Bunting	*Passerina amoena*	- ISpFT	
House Finch	*Carpodacus mexicanus*	-* CR	
Lesser Goldfinch	*Spinus psaltria*	-* UR	
Lawrence's Goldfinch	*Spinus lawrencei*	- IWV	

COMMON NAME	SCIENTIFIC NAME		REMARKS	
Green-tailed Towhee	Chlorura chlorura	-	CWV	
Rufous-sided Towhee	Pipilo erythrophthalmus	-	UWV	44
Abert's Towhee	Pipilo aberti	-*	CR	
Lark Bunting	Calamospiza melanocorys		UWV	
Savannah Sparrow	Passerculus sandwichensis	-	CWV	
Vesper Sparrow	Pooecetes gramineus		CWV	
Lark Sparrow	Chondestes grammacus		CWV	
Black-throated Sparrow	Amphispiza bilineata	*	UR	
Sage Sparrow	Amphispiza belli		CWV	
Slate-colored Junco	Junco hyemalis	-	A	45
Oregon Junco	Junco oreganus	-	UWV	
Gray-headed Junco	Junco caniceps	-	UWV	46
Chipping Sparrow	Spizella passerina	-	UWV	
Brewer's Sparrow	Spizella breweri		CWV	
White-crowned Sparrow	Zonotrichia leucophrys		CWV	
Lincoln's Sparrow	Melospiza lincolnii	-	UWV	
Song Sparrow	Melospiza melodia	-*	CR	47

Although the endangered clapper rail has been found both upstream and downstream, no definite nesting records have been found in the study area as yet.

The relatively rare areas of mature cottonwoods and willows provide nesting habitat for the following species:

Green Heron	Gila Woodpecker
Sparrow Hawk	Ladder-backed Woodpecker
Barn Owl	Western Kingbird
Screech Owl	Starling
Great Horned Owl	Lucy's Warbler
Black-chinned Hummingbird	Hooded Oriole
Gilded Flicker	Bullock's Oriole
Lesser Goldfinch	Bronzed Cowbird

Several other species such as the black-crowned night heron, black-bellied tree duck, Cooper's hawk, Harris'hawk, Wied's crested flycatcher, vermilion flycatcher, yellow warbler, and summer tanager, can be expected to breed in the area if cottonwoods and willows increase their distributions.

Non-avian Vertebrates

An inventory of reptiles, amphibians, mammals, and fish predicted to occur in the study area is shown in Tables 6 through 8. The inventory was compiled largely from available literature on Arizona vertebrates coupled with limited field sampling. Because they are occasionally in the floodplain, the list includes terrestrial species which would not normally be found there but would be expected to be present in the desert upland or desert wash communities adjacent to the floodplain.

ARCHAEOLOGY

The study area from the confluence of the Gila-Salt River to Gillespie Dam was nearly completely surveyed for archaeological remains in 1963. A total of 19 sites were located by Dr. William W. Wasley and R. Gwinn Vivian during a survey financed by the National Park Service. Two additional sites were located, one in 1963 north of the Estrella Mountains, and one in 1972 near Gillespie Dam.

Of these 21 sites, all but three are located on the south side of the river where agricultural development has been at a minimum (Table 9). Fifty years ago the surveys of Gila Pueblo, Globe, Arizona reported several sites along the north side. Recent attempts to relocate these remains proved unrewarding because most of these sites have been destroyed by agriculture.

None of the sites recorded are located within the floodplain and all but three are situated along the edge of the low terrace paralleling the river and are often in close proximity to small washes.

Table 6. Inventory of reptiles and amphibians in the study area.

Legend for Tables 5 through 7

+ = Enhancement to species populations
- = Detrimental to species populations
0 = Probably no effect on species populations
A = Abundant
C = Common
U = Uncommon
R = Rare
B = Breeding

* = Unlikely to occur in study area
** = Rare and/or endangered

Decrease Flow = Presumed decrease in density of vegetation
Increase Flow = Presumed increase in density of vegetation but no large-scale flooding or overflow
Flooding = Presumed periodic covering of floodplain by water and/or scouring floods that do considerable damage to vegetation

Scientific Name	Common Name	Relative Abundance	Aquatic or Riparian Dependency	Effect on Numbers of Individuals: Eliminate Flow	Decrease Flow	Increase Flow	Flooding
Ambystoma tigrinum	Tiger Salamander	?	Absolute (B)	-	-	+	+
Scaphiopus couchi	Couch's Spadefoot	C	Absolute (B)	-	-	+	+
Scaphiopus hammondi	Western Spadefoot	C ?	Absolute (B)	-	-	+	+
Bufo cognatus	Great Plains Toad	C	Absolute (B)	-	-	+	+
Bufo aluarius	Colorado River Toad	C	Absolute (B)	-	-	+	+
Bufo woodhousei	Woodhouse's Toad	C ?	Absolute (B)	-	-	+	+
Bufo punctatus	Red-spotted Toad	C	Absolute (B)	-	-	+	+
Rana pipiens	Leopard Frog	C	Absolute (B)	-	-	+	+
Rana catesbeiana	Bullfrog	C	Absolute (B)	-	-	+	+
Kinosternon sonoriense	Sonora Mud Turtle	U ?	Absolute (B)	-	-	+	+
Gopherus agassizi	Desert Tortoise	*	None	0	0	0	-
Trionyx spiniferus	Texas Softshell	U ?	Absolute (B)	-	-	+	+
Coleonyx variegatus	Banded Gecko	U ?	None (B)	0	0	0	-
Sauromalus obesus	Chuckwalla	*	None	0	0	0	- if present
Dipsosaurus dorsalis	Desert Iguana	U ?	None	0	0	0	-
Callisaurus draconoides	Zebra-tailed Lizard	A	None (B)	0 or +?	0	0	-

Scientific Name	Common Name	Relative Abundance	Aquatic or Riparian Dependency	Effect on Numbers of Individuals			
				Eliminate Flow	Decrease Flow	Increase Flow	Flooding
Holbrookia texana	Greater Earless Lizard	C	None (B)	0 or +?	0	0	-
Holbrookia maculata	Lesser Earless Lizard	U	None	0	0	0	-
Crotaphytus wislizeni	Leopard Lizard	*	None	0	0	0	-if present
Crotaphytus collaris	Collared Lizard	*	None	0	0	0	-if present
Sceloporus magister	Desert Spiny Lizard	U	None (B)	0	0	0	-
Sceloporus clarki	Sonora Spiny Lizard	U	None (B)	-	-	+	-
Urosaurus ornatus	Tree Lizard	C	Slight (B)	-	-	+	-
Uta stansburiana	Side-blotched Lizard	C	None (B)	-	0	0	-
Phrynosoma solare	Regal Horned Lizard	U	None	?	0	?	-
Cnemidophorus tigris	Western Whiptail	A	None (B)	-	-	+	-
Heloderma suspectum	Gila Monster	*	None	-	-	+	- if present
Leptotyphlops humilis	Western Blind Snake	U	Slight (B)	-	-	+	-
Phyllorhynchus decurtatus	Spotted Leaf-nosed Snake	*	None	?	?	-	- if present
Masticophis flagellum	Coachwhip	C	None (B)	-	-	+	-
Masticophis bilineatus	Sonora Whipsnake	U	Slight	-	-	+	-
Diadophis punctatus	Regal Ring-necked Snake	*	Moderate	-	-	+	-if present
Salvdora hexalepis	Desert Patch-nosed Snake	*	None	?	?	?	-if present
Pituophis melanoleucus	Gopher Snake	C	None (B)	-	-	+	-
Arizona elegans	Glossy Snake	U	None (B)	-	-	+	-
Lampropeltis getulus	Common Kingsnake	U	Slight (B)	-	-	+	-
Rhinocheilus lecontei	Long-nosed Snake	C	None (B)	-	?	?	-
Thamnophis marcianus	Checkered Garter Snake	C	Moderate (B)	-	-	+	+?
Thamnophis cyrtopsis	Black-necked Garter Snake	C *	Strong	-	-	+	+?
Sonora semiannulata	Western Ground Snake	U	None (B)	0	0	-?	-
Chionactis occipitalis	Western Shovel-nosed Snake	*	None	0	0	-	-

Scientific Name	Common Name	Relative Abundance	Aquatic or Riparian Depencency	Effect on Numbers of Individuals: Eliminate Flow	Decrease Flow	Increase Flow	Flooding
Chilomeniscus cinctus	Banded Burrowing Snake	*	None	0	0	-	-
Tantilla planiceps	Desert Black-headed Snake	?	Moderate (B)	-	?	+	-
Thamnophis eques	Mexican Garter Snake	U	Strong (B)	-	-	+	+?
Hypsiglena torquata	Night Snake	C	None (B)	-	-	+	-
Trimorphodon lambda	Lyre Snake	*	Slight (B)	?	0	0	-
Micruroides euryxanthus	Arizona Coral Snake	U	None (B)	?	?	?	-
Crotalus atrox	Western Diamond-backed Rattlesnake	C	None (B)	-	-	+	-
Crotalus molossus	Black-tailed Rattlesnake	?	Slight	-	-	+	-
Crotalus cerastes	Sidewinder	*	None (B)	+?	+?	?	-
Crotalus scutulatus	Mohave Rattlesnake	C	None (B)	-	-	+	-

Table 7. Inventory of mammals in the study area.

Scientific Name	Common Name	Relative Abundance	Aquatic or Riparian Dependency	Effect on numbers of Individuals: Eliminate Flow	Decrease Flow	Increase Flow	Flooding
Notiosorex crawfordi	Desert Shrew	U	None (B)	-	?	?	-
Macrotus californicus	California Leaf-nosed Bat	?	None ? Foraging Sites	-	-	+	0 or+
Myotis yumanensis	Yuma Myotis	C	"	-	-	+	0 or+
Myotis velifer	Cave Myotis	?	"	-	-	+	0 or+
Myotis californicus	California Myotis	?	"	-	-	+	0 or +
Pipistrellus hesperus	Western Pipistrelle	C	"	-	-	+	0 or +
Eptesicus fuscus	Big Brown Bat	?	"	-	-	+	0 or +
Lasiurus cinereus	Hoary Bat	?	"	-	-	+	0 or +
Euderma maculata **	Spotted Bat	R	"	-	-	+	0 or +
Antrozous pallidus	Pallid Bat	C	"	-	-	+	0 or +
Tadarida brasiliensis	Mexican Free-tailed Bat	U	"	-	-	+	0 or +
Eumops perotis	Western Mastiff Bat	U	"	-	-	+	0 or +
Lepus californicus	Black-tailed Jack Rabbit	C	None (B)	-	0	0	-
Sylvilagus auduboni	Desert Cottontail	C	Slight (B)	-	-	+	-
Citellus variegatus	Rock Squirrel	U	None	-	0	0	-
Ammospermophilus harrisii	Harris'Antelope Squirrel	U	None	+?	+?	0	-
Spermophila tereticauda	Round-tailed Ground Squirrel	C	None (B)	-?	0	0?	-
Thomomys bottae	Valley Pocket Gopher	C	Slight (B)	-	-	+	-
Perognathus longimembris	Little Pocket Mouse	*	None	?	0?	0?	-
Perognathus amplus	Arizona Pocket Mouse	C	None (B)	+?	0	0	-
Perognathus penicillatus	Desert Pocket Mouse	?	None (B)	+	+	-	-
Perognathus intermedius	Rock Pocket Mouse	*	None	+	+	0	-
Dipodomys merriami	Merriam's Kangaroo Rat	C	None (B)	+	+	-	-
Dipodomys ordi	Ord's Kangaroo Rat	?	None (B)	+	+	-	-
Dipodomys deserti	Desert Kangaroo Rat	*	None	+	+	-	-
Castor canadensis	Beaver	R	Absolute	-	-	+	+ ?
Onychomys torridus	Southern Grasshopper Mouse	U?	None	?	?	?	-
Reithrodontomys megalotis	Western Harvest Mouse	U?	None	-	-	+	-
Peromyscus eremicus	Cactus Mouse	*	None	+?	+?	-	-
Peromyscus maniculatus	Deer Mouse	A?	None (B)	-	-	+	-

Scientific Name	Common Name	Relative Abundance	Aquatic or Riparian Dependency	Effect on Numbers of Individuals: Eliminate Flow	Decrease Flow	Increase Flow	Flooding
Sigmodon hispidus	Hispid Cotton Rat	U	Slight	–	–	+	+?
Neotoma albigula	White-throated Wood Rat	*	None?	0	0	0	–
Neotoma lepida	Desert Wood Rat	*	None	0	0	0	–
Ondatra zibethicus	Muskrat	U	Absolute (B)	–	–	+	+
Mus musculus	House Mouse	U?	None	0?	0	0?	0 or–
Erethizon dorsatum	Porcupine	U	Moderate	–	–	+	–?
Canis latrans	Coyote	C	None (B)	–	–	+	–
Vulpes macrotis	Kit Fox	U	None	0	0	0	–
Urocyon cinereoargenteus	Gray Fox	*	Slight	–	–	+	–
Bassariscus astutus	Ringtail	*	None	–	–	+	–
Procyon lotor	Raccoon	C	Strong (B)	–	–	+	–?
Nasua narica	Coati	*	None?	–	–	+	–
Taxidea taxus	Badger	U?	None (B)	–	0?	0?	–
Spilogale putorius	Spotted Skunk	*	None	–	–	+	–
Mephitis mephitis	Striped Skunk	C	None (B)	–	–	+	–
Mephitis macroura	Hooded Skunk	*	None	–	–	+	–
Conepatus mesoleucus	Hog-nosed Skunk	*	None	–	–	+	–
Felis onca	Jaguar	*	None?	0	0	0	0
Felis pardalis	Ocelot	*	None ?	0	0	0	0
Felis concolor	Mountain Lion	R	None	–	0	0	–
Lynx rufus	Bobcat	U	None (B)	–	–	+	–
Tayassu tajacu	Javelina	U	Slight?	–	–	+	–
Odocoileus hemionus	Mule Deer	U	Slight	–	0	0	–
Odocoileus virginianus	White-tailed Deer	U	Slight	–	0	0	–

Table 8. Inventory of fish in the study area.

Scientific Name	Common Name	Effect on Numbers of Individuals: Eliminate Flow	Decrease Flow	Increase Flow	Flooding
NATIVE SPECIES					
Gila elegans**	Boneytail Chub	Presumed extinct in Gila River			
Gila robusta	Roundtail Chub	Presumed extince in Gila River			
Gila intermedia	Gila Chub	Presumed extinct in Gila River			
Meda fulgida**	Gila Spinedace	Presumed extinct in Gila River			
Plagopterus argentissimus**	Woundfin	Presumed extince in Gila River			
Ptychocheilus lucius**	Colorado River Squawfish	Presumed extinct in Gila River			
Agosia chrysogaster	Longfin Dace	Presumed extinct in Gila River			
Rhinichthys osculus	Speckled Dace	Presumed extinct in Gila River			
Tiaroga cobitis**	Loach Minnow	Presumed extinct in Gila River			
Catostomus insignis	Gila Sucker	-	-	+	+
Catostomus latipinnis	Flannelmouth Sucker	Presumed extinct in Gila River			
Pantosteus clarki	Gila Mountain	-	-	+	-
Xyrauchen texanus**	Razorback Sucker	Presumed extinct in Gila River			
Cyprinodon macularius	Desert Pupfish	Presumed extinct in Gila River			
Poeciliopsis occidentalis**	Gila Topminnow	Presumed extinct in Gila River			
INTRODUCED SPECIES					
Dorosoma petenense	Threadfin Shad	-	-	+	+
Cyprinus carpio	Carp	-	-	+	+
Carassius auratus	Goldfish	-	-	+	+
Notemigonus crysoleucus	Golden Shiner	-	-	+	+
Notropis lutrensis	Red Shiner	-	-	+	+
Pimephales promelas	Flathead Minnow	-	-	+	+
Ictalurus punctatus	Eastern Channel Catfish	-	-	+	+
Ictalurus melas	Black Bullhead	-	-	+	+
Ictalurus natalis	Yellow Bullhead	-	-	+	+
Poecilia latipinna	Sailfin Molly	-	-	+	+
Poecilia mexicana	Mexican Molly	-	-	+	+
Lebistes reticulatus	Guppy	-	-	+	+
Xiphophorus variatus	Variegated Platyfish	-	-	+	+

Scientific Name	Common Name	Effect on numbers of Indivicuals			
		Eliminate Flow	Decrease Flow	Increase Flow	Flooding
Gambusia affinis	Mosquitofish	−	−	+	+
Micropterus salmoides	Largemouth Bass	−	−	+	+
Lepomis machrochirus	Bluegill	−	−	+	+
Lepomis microlophus	Redear Sunfish	−	−	+	+
Lepomis cyanellus	Green Sunfish	−	−	+	+
Pomoxis nigromaculatus	Black Crappie	−	−	+	+
Tilapia mossambica	Mossambique Tilapia	−	−	+	+

Table 9. Inventory of Archaeological remains in the study area.

Arizona State Museum Site No.	Type of Site[1]	Time Period	Location
Ariz. T: 9:1	Ballcourt	A.D. 1250-1400	T2S,R5W,S15,SW 1/4
Ariz. T: 9:2	Village	A.D. 900-1250	T2S,R5W,S15,NW 1/4
Ariz. T:10:1	Dugout	Historic Anglo	T1S,R5W,S26,SW 1/4
Ariz. T:10:2	Village	A.D. 1250-1400	T1S,R5W,S26,SE 1/4
Ariz. T:10:3	Sherd area	A.D. 1250-1400	T1S,R5W,S25,SE 1/4
Ariz. T:10:4	Sherd area	A.D. 1250-1400	T1S,R5W,S36,NE 1/4
Ariz. T:10:5	Sherd area	?	T1S,R4W,S30,SE 1/4
Ariz. T:10:6	Village	A.D. 1250-1400	T1S,R4W,S28,NW 1/4
Ariz. T:10:7	Sherd area	A.D. 1250-1400	T1S,R4W,S27,NW 1/4
Ariz. T:10:8	Sherd area	A.D. 900-1200+	T1S,R4W,S27,NW 1/4
Ariz. T:10:9	Sherd area	A.D. 500-900	T1S,R3W,S19,SE 1/4
Ariz. T:10:10	Sherd area	A.D. 1250-1400	T1S,R3W,S17,SE 1/4
Ariz. T:10:11	Sherd area	A.D. 1250-1400	T1S,R4W,S16,SE 1/4
Ariz. T:11:18	Sherd area	A.D. 1250-1400	T1S,R2W,S7,SE 1/4
Ariz. T:11:19	Sherd area	A.D. 900-1250	T1S,R2W,S9,NW 1/4
Ariz. T:11:20	Sherd area	A.D. 900-1250	T1S,R2W,S4,SE 1/4
Ariz. T:11:21	Sherd area	A.D. 1250-1400	T1S,R2W,S3,SW 1/4
Ariz. T:11:22	Sherd area	A.D. 1250-1400	T1N,R2W,S34,SW 1/4
Ariz. T:11:24	Sherd area	A.D. 1250-1400	T1N,R1W,S30,SW 1/4
Ariz. T:13:14	Sherd area	A.D. 1250-1400	T2S,R5W,S21,SE 1/4
Ariz. T:13:17	Petroglyphs	?	T2S,R5W,S21,SW 1/4

1/Sites have been designated villages where visible architecture is present. Most of the sherd areas are probably pithouse villages which have no surface manifestations.

ECONOMIC AND SOCIAL

Agriculture

Agriculture and husbandry are clearly the major users of land in and around the study area and, in terms of both employment and income, would appear to be the dominant source of livelihood for area residents.

The agricultural acreage under cultivation is considerable (Table 3) and extends well onto the floodplain of the Gila. In some cases, even the main channel of the Gila is, or at least has been, under cultivation (Figure 1).

The relative acreage devoted to the area's several important crops is difficult to determine since cropping patterns will vary from season to season and from year to year as farmers make periodic adjustments in light of changing market conditions and soil quality. A rough description of the relative importance of several different crops in terms of the acreage is as follows:

Arlington area:

Small grains (including barley and wheat)	= 30%
Cotton	= 20%
Alfalfa	= 15%
Sorghum	= 15%
Safflower	= 15%
Sugar beets	= 5%

Palo Verde area-Buckeye area:

Small grains	= 30%
Cotton	= 25%
Safflower	= 20%
Alfalfa	= 15%
Sorghum	= 5%
Sugar beets	= 5%

Liberty area:

Small grains	= 27%
Cotton	= 25%
Safflower	= 20%
Alfalfa	= 18%
Sorghum	= 5%
Sugar beets	= 5%

Although there is some pasture land in the study area and animals are occasionally allowed to feed on cropped fields, most livestock is confined to feed lots or dairies. There are seven dairies and two beef feeding operations in the Arlington area and two pig farms in the Buckeye-Allenville area. The dairy farthest east is located to the north of the Gila River and west of 115th Avenue. A second dairy is located to the west of the Gila-Agua Fria confluence and north of Casey Abbott Park, and a third near the intersection of Perryville Road and U.S. Highway 80. Four dairies are located along Airport Road on the north bank of the Gila River.

Hunting and Fishing

Both hunting and fishing are popular within the study area. Fisherman appear to be almost exclusively of local origin. In fact, it seems as though those fishing here are generally the rural poor who are resident within the immediate vicinity. That most fishermen appear to be locals, and that this group's recreational expenditures may be relatively small, should not diminish the importance of this recreational resource. To the low income minority group populations of Allenville and other area communities, fishing seems to be important; individuals and entire families utilize this resource at almost no cost to themselves.

Similarly, small game hunting probably attracts relatively few participants from outside the immediate area. When hunters from metropolitan Phoenix or elsewhere come into the area, they probably contribute little to the local economy.

Whitewing and mourning doves are clearly among the most important game animals found within the study area. This is one of the better whitewing production areas in Arizona. The importance of this wildlife resource can be measured both in terms of its dollar value to the local and larger Maricopa County business community and to the Arizona Game and Fish Department. But, there is still an unmeasured psychic income for the large body of hunters in nearby Phoenix and for those coming to the area from elsewhere in Arizona, California and from other states.

The study area is also important in terms of waterfowl production. It is much more accessible to Arizona's large population centers, than the Colorado River area, and consequently is heavily hunted by Arizona residents. A variety of waterfowl are taken, especially pintails, blue and cinnamon teals, and the Great Basin Canada Goose.

There is considerable public land in the study area which is part of the Greenbelt. The Arizona Department of Game and Fish owns or has jurisdiction over large land parcels, including the Arlington Wildlife Area with associated ponds and grain fields, the Robbin's Butte Game Management Unit with associated grain fields, the wildlife flowage near the confluence of the Salt and Gila Rivers and wildlife area about a mile east of Allenville. The Copper State Game Club is located near the confluence of Agua Fria and Gila Rivers.

There are considerable expenditures by hunters for resident and non-resident permits, for guns and ammunition, and for transportation, food and lodging. The largest share of these expenditures appears to be largely confined to the Phoenix area. Resident hunters usually come from the State's urban centers and especially the Phoenix area; in most cases these are commuter hunters who spend very little money in the areas they hunt. Similarly, hunters from out of state frequently stay in Phoenix and simply make day excursions to the hunting areas along the Gila River.

Even when hunters stay within the study area their economic contribution to the local economy is of only minor magnitude. In recent years the annual hunting season for whitewings has been only 12 days in length. Furthermore, a large share of the hunting is done in the first three or four days of the season and especially on the first day. At best, hunters will spend two or three nights at a local motel and purchase a few meals and other items from local merchants. The owner of the largest motel located in close proximity to the study area estimated that he served one-half to two-thirds of the dove hunters who stayed in the area in commercial accommodations. Additionally, he estimated that his gross income from hunters was about $600.00 in 1972. However, hunters occupied units that might have been rented to others, so the $600.00 figure might be adjusted downward downward to about $450.00. This second figure would represent the contribution by hunters over and above "normal" revenues for this time of year. If we assume that this motel has approximately 50% of the area's rental units, the total net contribution by dove hunters to the local economy for lodging might be set at approximately $1,000.00.

The study area provides habitat for a number of small game species including mourning dove, whitewing dove, quail, rabbit, and waterfowl.

Data on small game harvests and hunters are available at the state scale and sometimes even at the county scale, but data are not readily available at larger scales (see _Arizona Game Management Data Summary_, Arizona Game and Fish Commission, 1972). This lack of data for large scale observation units makes it difficult to analyze the importance of the game resource in localized areas.

William E. Martin and Arthur H. Smith, Department of Agricultural Economics, University of Arizona, are currently analyzing data collected for a project funded by the Arizona Game and Fish Department. Robert A. Jantzen, Director and Robert D. Curtis, Chief, Wildlife Planning and Development Division were kind enough to release these data prior to publication so that they might be used in this study; Dr. Arthur Smith spent several days sorting through the mass of detailed data to identify those survey respondents who were whitewing hunters. Because of the excellent cooperation of both the researchers and the funding agency, this study is based upon data collected at a sub-county level. Specifically, data show the county of origin of Arizona residents who hunted whitewing doves in 1970 and the game management unit in which they hunted.

The study area lies in three Arizona Department of Game and Fish management units, numbers 39, 41 and 42 (Figure 4). Unfortunately these management units are expansive and include large areas beyond the margins of the study area. Nevertheless, these data are presented as the best approximation of study area data. Actually, the distortion may not be great since a good share of the whitewing hunting in these management units is associated with the study area.

Some 25 hunters, or about 25 percent of those surveyed in the State, hunted whitewing in management units 39,41 and 42 (Table 10), while 34 respondents were identified as hunting some combination of squirrels, cottontails, mourning doves, whitewing doves, and quail (Table 11). Investigation of questionnaires suggests that 30 or approximately 90 percent of the combination hunters, are whitewing hunters.

If it is assumed that the relative importance of small game hunters is fairly represented by the 702 total identified by Martin and Smith and that 20 percent or 140 of these small game hunters are also whitewing hunters, then management units 39,41, and 42 serve about 39 percent of the State's whitewing hunters:

$$25 + 30 = 55 \div 140 = 39\%$$

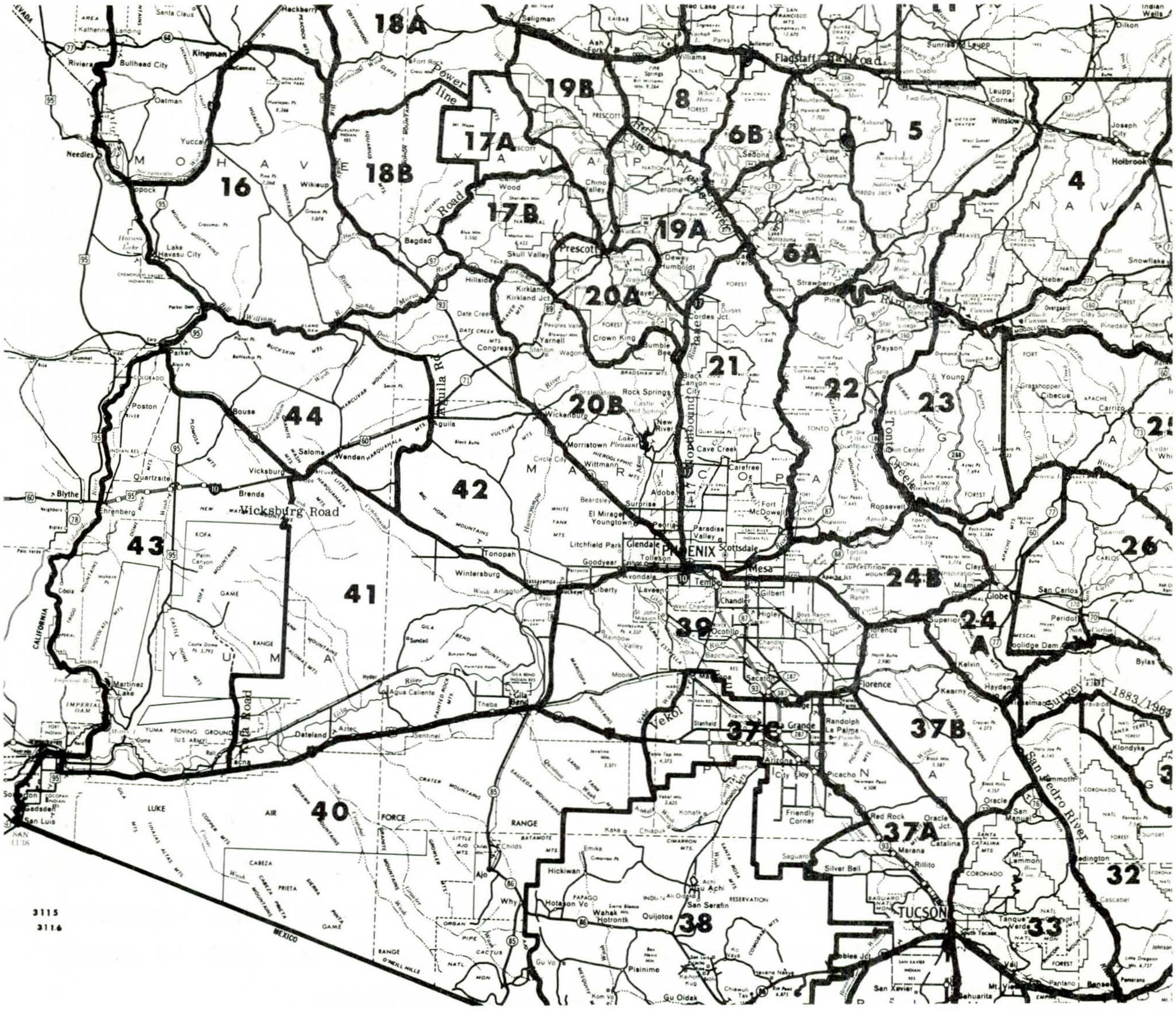


Figure 4. Arizona Department of Game and Fish Game Management Units.

Table 10. Whitewing hunter origins and destinations.

A Origins of Respondents (by County)	B Total Number of Responses Mentioning Whitewing	C Number of Responses-Hunted Whitewing in Management Units 39, 41 and 42	D C ÷ B = %	E Responses-Management Unit # 39	F Responses-Management Unit # 41	G Responses-Management Unit # 42
Yuma	23	7	30.43	0	7	0
Mohave	2	0	0.0	0	0	0
Pima	20	1	5.00	0	1	0
Santa Cruz	1	0	0.00	0	0	0
Pinal	9	1	11.11	0	1	0
Maricopa	20	13	65.00	9	0	4
Cochise	9	1	11.11	0	1	0
Greenlee	2	0	0.0	0	0	0
Graham	3	0	0.0	0	0	0
Gila	6	0	0.0	0	0	0
Yavapai	3	0	0.0	0	0	0
Coconino	3	2	66.67	0	1	1
Apache	0	0	0.0	0	0	0
Navajo	3	1	33.33	1	0	0
State	104	26	25.00	10	11	5
Total Respondents	95	25	26.32	--	--	--

Note: Several respondents made two or more responses.

Table 11. Combination hunters of small game and whitewings.

A Origins of Respondents (by County)	B Total Number of Responses Mentioning Combinations	C Number of Responses-Hunted Combination of Species in Management Units 39,41,42	D C ÷ B = %	E Responses-Management Unit # 39	F Responses-Management Unit # 41	G Responses-Management Unit # 42
Yuma	52	4	7.69	0	4	0
Mohave	21	1	4.76	1	0	0
Pima	25	1	4.00	1	0	0
Santa Cruz	1	0	0.0	0	0	0
Pinal	7	0	0.0	0	0	0
Maricopa	53	30	56.60	17	4	9
Cochise	20	0	0.0	0	0	0
Greenlee	1	0	0.0	0	0	0
Graham	2	0	0.0	0	0	0
Gila	13	1	7.69	0	0	1
Yavapai	8	0	0.0	0	0	0
Coconino	6	0	0.0	0	0	0
Apache	2	0	0.0	0	0	0
Navajo	11	0	0.0	0	0	0
State	222	37	16.67	19	8	10
Total Responses	191	34	17.80	--	--	--

Note: Several respondents made two or more responses.

Perhaps the best way to illustrate the economic importance of the whitewing is to build a profile of the "typical" Arizona (resident) whitewing hunter. Initially, two generalizations can be made:

Judging from data collected by Martin and Smith (Appendix B and C), it seems fair to assume that the "typical" whitewing hunter spends an estimated $12.00 for each hunting trip.

a. 120 miles at $0.05 per mile =	$6.00
b. he is a "commuter" and, therefore, spends nothing for lodging =	0.00
c. food =	1.50
d. other (ammunition etc.) =	4.50
	$12.00

These expenditures presumably represent the direct expenditures per trip. Hence, auto expense is calculated as $0.05 per mile, not $0.10 or $0.12; food cost is the cost of food above what it would cost the hunter if he simply stayed home; "other" includes expendables and not expenditures for guns, boots, licenses, and other such items.

Additionally, assume that this "typical" hunter takes 0.5 companions with him on each trip. Although the auto expense has already been accounted for, this companion will need "food" and "other" estimated expenditures totaling $3.00. Then the "typical" whitewing hunting party will spend $15.00 per trip.

If the "typical party" makes four trips each year, their total direct expenditures will be $60.00. Since there are thousands of whitewing hunters in Arizona, aggregate expenditures are sizable (Appendix D).

The State of Arizona and especially the hunter's home community probably benefit most from the whitewing resource in economic terms. Benefits come from "direct" expenditures from ammunition and gasoline, from "overhead" expenditures for guns and other equipment and from license sales. Additionally, hunters from out-of-state are a source of export income.

The local area with the whitewing resource probably sees only a small portion of the money spent. The typical hunter is a commuter who may purchase gasoline, food and other items at home before going on his day-trip. Even out-of-state hunters spending relatively large sums for travel, food, and lodging may stay in a major center, such as Phoenix, and commute to hunting areas. Furthermore, the whitewing season is so short that expenditures by hunters could hardly be expected to support any significant segment of a local area's economy.

Other Recreation

The study area has the potential to support a variety of recreational activities in addition to those mentioned in the discussion on hunting and fishing. The Phoenix Raceway located near the east end of the study area and the golf course and picnic facilities found in Maricopa County's Casey Abbott Semi-Regional Park (Figure 1), represent a substantial capital investment and returns may be sizable. For example, the monthly income from the Casey Abbott Golf Course ranges from a low of $5,400.00 in August to $6,500.00-$7,500.00 in the winter months (1971 data).

Existing data tell us little about the nature or importance of other recreational use of the area, but the numbers participating in miscellaneous recreational activities appears to be small and their economic impact negligible. The main channel of the Gila and adjacent areas do get some minor use by off-the-road vehicle buffs, target shooters, bird watchers, dog trainers, and others. The Bureau of Land Management has a scenic lookout on the south side of the U.S. 80 crossing.

There is a future potential for use by hikers and horsemen since this portion of the Gila River has been designated for inclusion in the Maricopa County trail system. However, at this point there are no plans to develop trails within the river channel area or to create resting and watering stops for trail users. Potential recreation is severely limited by lack of access to the area and by dense tamarisk or surface water which restricts travel.

Settlement

Estimating the population in, or adjacent to, the study area is difficult. Data collection areas defined by the Bureau of the Census do not even roughly conform to the general area under study. In fact, the Gila River serves as the boundary between the four County Census Divisions which cover the study area and a great deal of additional territory. These four Divisions contain 43,716 people (1970 data). However, of that number, 29,221 people live in towns, cities or unincorporated settlements which are clearly outside of the study area. Of the remaining 14,495 people, 2,599 live in the town of Buckeye on the north margin of the study area and perhaps an additional 1,000-2,000 people live in rural-dispersed settlements or hamlets in, or in close proximity to, the study area. Four thousand people is probably a reasonable estimate of study area population.

The pattern of settlement in and around the study area is characteristically rural-dispersed, i.e. agriculturalists live on their individual holdings. Additionally, there are a few limited areas which appear to contain a rural-dispersed non-farm population on individual holdings of one or two acres. Residents here may be exurbanites, i.e., commuters who live beyond the suburbs. There are also a few agglomerated settlements with some associated commercial activity. Buckeye is the only major center and the few other smaller settlements are probably best described as hamlets. The number of residential units is small and the functions provided are few in number and of a low order, e.g., a post office, grocery store, church, service station or elementary school. There is a sewage treatment plant and a gravel pit in the floodplain immediately south of Buckeye and gravel mining has occurred in the other locations in the study area.

ENVIRONMENTAL AND ECOLOGICAL PROBLEMS

Most environmental and ecological problems in the study area appear to be related to continuing manipulation of the environment by man. The historical and relatively natural ecological balance in the floodplain and adjacent areas had been altered even before the beginning of this century although many major changes, including the large scale invasion of tamarisk, have been more recent. Hence, the study area is not a natural environment. This does not imply however, that the ecosystem is not worthy for supporting wild populations of plants and animals. On the contrary, many similar floodplain communities in Arizona and the Southwest have been so radically changed or destroyed that the value of the study area is enhanced. However, the great variety of man's manipulations in the study area, many of which have been essentially uncontrolled in terms of their ecological impact, might be less adverse or more beneficial for wild plants and animals if the area was managed for multiple use. Effective multiple use management could emphasize preservation or enhancement of wildlife as part of a comprehensive plan which includes values of public recreation, flood, erosion, and salinity control; water conservation; and agricultural, social, or historical values. Problems in the study area include the following:

1) Floodplain vegetation is dominated by the exotic tamarisk which has great value for nesting doves, but tends to exclude other plants and is of very limited value for other animal populations, and most types of recreation. Tamarisk may hinder the future establishment of more desirable floodplain species such as cottonwood and willow. It transpires large quantities of water and tends to increase flood damage potential by choking channels and spreading flood flows.
2) The Congress has authorized a 2000 foot-wide channel for flood control in the study area which would remove a considerable portion of floodplain wildlife habitat if construction were to take place. However, preparation of a project plan has been deferred, pending a specific request by local interests to complete the project.

3) The sources of surface flow are partially controlled or modified by man and include controlled release from upstream dams, flows from irrigation runoff and wastewater, and treated Phoenix sewage effluent. Significant changes in surface flow sources, aside from floods caused by heavy precipitation, could affect floodplain biotic communities particularly fishes, amphibians and waterfowl.
4) The high salinity of pumped groundwater, particularly in the Buckeye area, as well as irrigation runoff, restrict the diversity of agricultural crops and wild plant and associated animal species which can thrive in the area. Moreover, salinity may increase in the future.
5) Lowering of the groundwater table east of Waterman Wash has seriously restricted floodplain vegetation growth and related habitat conditions for associated animals. Raising of the groundwater table west of Waterman Wash has apparently fostered the explosive invasion of tamarisk and may enhance its continued dominance of the area. Future groundwater changes may have similar effects.
6) Further agricultural, urban, or industrial development may result in future clearing of floodplain land and the loss of wildlife habitat.
7) Hundreds of acres of tamarisk in the study area have been burned over the past 20 years and the potential for future fires is high, particularly during the arid seasons. Some of the fires have been set deliberately in order to clear the land, but sometimes have apparently continued to burn out of control. Although above ground parts of tamarisk may be destroyed by fire, the plants readily sprout again. However, the replacement of tall trees obviously takes many years, and burned areas are characterized for a long time by scrub vegetation which is generally not esthetically pleasing or a desireable habitat for wildlife.

8) Solid waste has been dumped illegally throughout the floodplain. This results in unsightly conditions, destruction of habitat, a source of pollution during flood flows, and a costly and difficult cleanup job.

9) The whitewing doves, which nest in great numbers in tamarisk and mesquite, are dependent for both food and water on the irrigated agricultural ecosystem manipulated by man. Cultivated crops, particularly grains, may make up more than 40% of the whitewing's diet, particularly the different varieties of sorghum. Changes in cropping patterns to other varieties, or to late maturing grains, may seriously limit the whitewing's food supply and result in a significant decrease in the population, regardless of the availability of floodplain trees for nesting or in significant changes in flood flow rates.

10) The lack of a detailed ecological history in the study area, a record of environmental manipulation by man, and the many unknown facets of man's future manipulations, make a meaningful prediction of future changes in the floodplain difficult.

ENVIRONMENTAL IMPACTS OF A SIGNIFICANT INCREASE IN FLOW RATES

Flood flows in the study area are infrequent and do not result in long duration surface flows. An increase in flood flow rates because of manipulation by man in the drainage basin is not expected to greatly increase the duration of flows. However, small surface flows through much of the study area will probably be maintained if treated Phoenix sewage effluent and irrigation waste water continue to flow into the channel.

A significant increase in the rate of flood flows would result in great and widespread damage to residential, business, industrial, and agricultural areas, irrigation works, highways, roads, railroads and utilities in the study area. The considerable flood damage expected from a standard project flood of 300,000 cfs (without the proposed Orme Dam) in the study area (see Figure 1 for flood boundaries), has been estimated by the Corps of Engineers in the 1959

Interim Report for Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona. Damage resulting from a significant increase in flood flow rates would then be potentially even greater and urban, industrial and other developments in the watershed have probably increased potential runoff since the Corps' study was made.

In addition to the greater damage to agricultural land and irrigation facilities, transportation networks, and small residential areas, the City of Buckeye, with more than 2,500 inhabitants, could be endangered.

The areas of greatest concern would probably be west of the Waterman Wash confluence, particularly the area where the Gila River turns south at Power's Butte. The dense tamarisk growth west of Waterman Wash would tend to significantly spread flood flows and the high water table would preclude great infiltration. The floodplain near Power's Butte is relatively narrow and would constrict the flood flows and increase velocities (Figure 3). In addition to erosion and uprooting of trees, flood flows would tend to inundate the floodplain for a considerable distance west of Power's Butte.

Hydrology

The flow rate in the study area is governed by the natural flow of the Santa Cruz River, the Gila River below Coolidge Dam, the Salt River below Stewart Mountain Dam, the Verde River below Bartlett Reservoir, the New River, the Agua Fria River below Lake Pleasant Reservoir (Waddell Dam), and Hassayampa River, Centennial Wash, the controlled releases from Lake Pleasant, Bartlett, Sahuaro and San Carlos Reservoirs, and the numerous diversions.

It is obvious that the extreme high flow conditions in the study area will depend not only on the extent and intensity of storm precipitation and snowmelt, but also on the reservoir volumes available for storage. If we take the flow at or below Gillespie Dam as representative of the peak flow rates in the study area and an analysis of the December, 1965-January, 1966 flood records shows that this is indeed the case, then the largest flow on record is the estimated peak discharge of 250,000 cfs in 1891. This was of course before the construction of Roosevelt, Lake Pleasant, Stewart Mountain, Coolidge and Bartlett Dams. Since then, the maximum recorded flow rate is 64,200 cfs on January 2, 1966. According to the U.S. Geological Survey evaluation, this flood has a recurrence interval of 35 years under present regulated conditions. According to the same source, the peak discharge-frequency relationship at Gillespie Dam under regulated conditions is as follows:

Mean Annual Flood:	3,500 cfs
10-yr. flood:	31,000 cfs
25-yr. flood:	58,000 cfs
50-yr. flood:	80,000 cfs

No evaluation has been made for lower probability floods, but if one takes the liberty of extending the curve defined by this relationship, the value of the 100-yr. flood turns out to be 115,000 cfs. It should be remarked, however, that without the reservoir system, the 1965-66 Phoenix flood would have a return period of only 7 years; under the same conditions the 50-yr. flood could have a peak discharge of around 200,000 cfs.

It should be pointed out that extrapolation beyond the 50-yr return period is speculation and is not based on actual data. In this report water levels were drawn, flow velocities were calculated, and the flood-plain boundaries indicated for a peak discharge of 300,000 cfs (Figures 1 and 3). The January, 1966 flood boundary (Figure 3) was drawn from black and white flood stage photographs provided by the Phoenix Office of the U.S. Geological Survey. In the light of the peak discharge-frequency relationship given above, such a flow rate would represent a rare, but possible event. The probable effects of this extreme discharge on the various physical aspects of the study area are discussed below,

The mean flow velocities shown on Figure 3 represent the average value over the cross-section. Where there are well defined channels, the actual value may considerably exceed this mean value. The result will be that well defined channels will be enlarged by scouring in the bottom and along the banks.

In the area between Robbin's Butte and Power's Butte where the floodplain and the flow-area become gradually constricted, the high velocities (5-10 fps) will cause considerable erosion and uprooting. In parts of the floodplain where there are no well defined channels, new channels may be cut at random, the pattern of which is impossible to predict. The scouring action of the high flows in the Santa Cruz, Gila, Salt, Agua Fria, and Hassayampa Rivers and in the numerous washes, will put large amounts of sediment in suspension. Wherever the flow velocities and the accompanying turbulence are reduced, the sediment in suspension will settle. Since the size of sediment in suspension is a function of flow velocity, the finer silt size particles will settle where the flow velocities are very small or zero, i.e., in overflow areas which act as storage reservoirs rather than conveyance channels.

Investigations by the U.S. Geological Survey in April, 1965 have shown that 20,000 acre feet of water released from Granite Reef Dam into the dry Salt River percolated almost totally into the river bed at rates varying between 1.4 feet/day and 2.5 feet/day. The same investigation showed that between Stewart Mountain Dam and Granite Reef Dam, where the river bed is normally wet, the percolation was practically nil. Observation during the December, 1965-January, 1966 flood showed a slightly delayed, but increasing level in several wells along the Salt and Gila Rivers. Rises of 35 to 40 feet were measured in wells along the Salt River downstream from Granite Reef Dam. Close correlation between rises in groundwater levels and streamflow in the Salt and Gila Rivers, indicated that a large part of the water lost from surface flow during the Phoenix flood infiltrated into the groundwater reservoir.

Calculations show that for a 3 month period from December, 1965 to March, 1966, 648,000 acre feet of water flowed into the study area, 10,000 acre feet were diverted by the Buckeye Canal, and 434,000 acre feet flowed out at Gillespie Dam. For water year 1966 these values were:

Inflow (acre feet)	Diversion (acre feet)	Outflow (acre feet)
710,000	42,000	453,000

Estimated infiltration for the 3 month period was 215,000 acre feet. It is difficult to say what percentage of this quantity is actual recharge to the groundwater reservoir, and what percentage is transpired by vegetation. A rough estimate would indicate that as much as 100,000 acre feet or about 50% could have reached the groundwater reservoir.

A significant increase of surface flow into the study area would be instrumental in recharging the groundwater reservoir. Just where the recharge would take place, and how much it would be, is difficult to estimate. Usually, the recharge would be greatest where the ground is of coarse alluvial material. In stagnant areas where successive floods have deposited fine silty material, the infiltration rate would be slow, and the potential evapotranspiration rate high. The percentage of the surface flow reaching the groundwater reservoir would also be a function of the total annual volume as well as its time distribution. A large annual flow volume would provide a higher percentage of groundwater recharge than a small volume. The same large quantity of surface flow, separated by periods of dry weather, would in general cause a greater recharge.

A very large volume of surface flow in any one year or sustained large flows over several years could cause waterlogging of the Gila floodplain near Buckeye where the water level is already very close to the surface.

The quality of groundwater in the study area is poor. Samples taken from wells in the area show a TDS content varying from 2700 ppm to 6000 ppm. Salt balance calculations for the years 1965-1969 showed that the total salt transport by surface water out of the study area at Gillespie Dam was greater than the total inflow from surface sources. For the dry years 1965, 1967, and 1969, the net transport out was 30,000, 30,000 and 13,000 tons respectively. For the wet years 1966 and 1968, the net transport out was 420,000 tons and 121,000 tons respectively. Significantly increased flows would take more dissolved solids out of the region than they would bring in and thus maintain or improve the quality of groundwater in the region.

Vegetation

The short term impact of increased flood flow rates on tamarisk would probably be adverse in the main channel area because trees would be washed out. However, the widely spreading flood waters would be slow to recede, and silt deposits with saturated soil conditions might be provided for several weeks. Such habitat conditions are ideal for germination and establishment of tamarisk (Horton, et al. 1960).

Unless the tamarisk root system is washed out by flood flows, the recovery after flooding should be relatively rapid, particularly with a higher groundwater table. Hence, the long term impact of a significant increase in flood flow rates would be beneficial to tamarisk and enable it to increase in plant size, community size, and community density.

The short term impact of floods on the mesquite community and on the scattered trees of cottonwood and willow would be similar to that of tamarisk. However, the recovery of mesquite would probably be slower than that of tamarisk. Because of deposited silt, saturated soil conditions, a higher groundwater table, and a prodigious amount of available seed at warmer times of the year, tamarisk germination and establishment in flood damaged mesquite areas, and where cottonwood and willow are found, would probably be high except for floods occurring in winter. Hence the short and long term impact of significantly increased flood flows would probably be adverse for many mesquite communities and for many of the cottonwood and willow trees in the floodplain.

The short term impacts on saltbush communities would probably also be adverse because of the removal of shrubs by flood flows. Long term impacts could also be adverse if large amounts of salts were washed from the soils. In this case the ubiquitous tamarisk would probably replace saltbush and greasewood. The loss of saltbush communities would not be serious in terms of wildlife or esthetics and the gain of tamarisk appears to have little value other than eventual nesting sites for doves. Tamarisk would transpire more water than would a saltbush community, tending to increase the salinity of remaining groundwater and the esthetics would probably not be improved.

Most cattail communities would probably be washed out by a significant increase in flood flow rates. On the other hand, the flows might scour out new sites where cattails could become established if an adequate seed source were available. The relatively small area now covered by cattails would probably preclude a large supply of seed for future dispersal. However under natural conditions, cattails have survived and even thrived on repeated flooding and have become reestablished. Impacts on other species populations are indicated in Table 4.

Animal Life

Beneficial and adverse impacts from a significant increase in flow rates are indicated for non-avian vertebrates in tables 6 through 8 . The effects of flooding would depend largely on the extent and nature of floods. Very heavy, rapid flow resulting in severe scouring of the floodplain would probably not be beneficial to any terrestrial or semiaquatic species, but could facilitate dispersal of some fishes. Most terrestrial populations could recover from severe flooding provided there is a considerable period between major inundations. Frequent (2-3 per year), widespread floods could effectively eliminate many terrestrial species, particularly in spring and summer when reproduction occurs.

Fish species such as the roundtail chub, Gila chub, Gila spinedace, woundfin, longfin dace, loach minnow and flannelmouth sucker could conceivably become reestablished if remnant populations are extant or could be reintroduced back into the Gila River system. Reestablishment could only occur with the removal of exotic competitors and the establishment of a flowing river with connecting marshes.

The adverse impact of a significant increase in flood flows would be a minor one for much of the year for the avifauna in the study area because the birds could avoid the floods. However, uprooted trees would reduce the number of nesting sites and floods which occur in summer could drown nestlings, destroy eggs, or remove nests. Whitewing and mourning dove nestlings, on the ground and in nests, would probably sustain the greatest losses in a summer flood. If floods occur in July and August, whitewings would probably not attempt to nest again that summer, but if floods damage nesting areas before July, whitewings would probably make considerable efforts at re-nesting in adjacent trees in the study area.

A long term increase in tamarisk size and distribution in the area as a result of increased flooding, would provide additional whitewing nesting sites and a potential increase in the dove population if nesting sites are a limiting factor.

If flooding destroys cattail marshes and they are not re-established, bird species nesting in these marshes would disappear or be significantly reduced in numbers. On the other hand, an increase in cattail marsh area would provide valuable new habitat for larger populations and distributions in the study area of these relatively uncommon species (Table 5).

Archaeology

Generally speaking, a significant increase in flow rate would have little effect on the recorded archaeological sites, regardless of the season of occurrence or duration of the high flow rate. Only one site (Gila Pueblo's A:11:6, reported in 1928) is believed to have suffered damage in the recent past due to the normal action of the Gila River near the study area. The threat of potential flooding might inhibit the trend for agricultural and urban development in the flood plain and along the terraces adjacent to it. If this development were to be stopped or reduced, fewer archaeological sites would be in danger of destruction. The terraces immediately adjacent to the river floodplain were most important as habitation and economic resource loci for prehistoric peoples.

Economic and social

With a significant increase in flood flows, the potential for loss of life and property also increases, but in view of the attitudes of some local residents to the flood hazard, the present flood potential is one which they are prepared to accept. Feedlots, farm buildings, private residences, a golf course and even a school are located within a zone of potential flood hazard. But the recent history of flooding is such that local residents are willing to stay in flood-prone areas with the hope of making enough money from the land in good years to offset the bad ones.

Although some farmers will use their most flood-prone lands for pasture, crops are grown in high hazard areas in most years. Even if flood waters do flow over cultivated fields, the crop may be damaged, but can still usually be harvested.

One farmer who cultivates a large amount of flood-prone land, noted several potential dangers: complete loss of crop, fields that are so wet that a new crop can not be planted on schedule, large accumulations of salt, silt, sand or gravel, destruction of irrigation ditches, and loss of fences or buildings. The same farmer said that he had been farming in the Arlington area since 1945 and had only sustained a major loss in one year, 1966. His crop was late that year and was still unharvested when flood waters hit. Of 260 acres in cotton, 240 were lost. If the direct production cost for seed, fertilizer, water, etc. is placed at $210 per acre, the loss, exclusive of any profit, could be estimated as $50,400. In addition, this farmer had to replace roughly one-half mile of concrete irrigation ditch (estimated cost=$ 2,500.00) and fences, and had to level fields which were down-cut or loaded with sand and gravel. There was also an unestimated additional cost from loss of production on the same fields in following years because of salts which had accumulated during the flood. This farmer is still cultivating the same flood-prone fields and the good years more than compensate for the occasional bad one. Similarly, a feed lot in the Arlington area (owned by Ronald Jolley) has also been flooded, yet it still persists. When a flood threatens, the cattle are simply moved to higher ground.

Related to the flood problem is the desire of most farmers to see the Gila's channel stabilized. This would allow a riverward expansion of cultivated lands and would reduce flood threat to lands already under cultivation.

The Gila River slows and deposits sand and gravel as it turns south after following a relatively narrow channel at Power's Butte. Farmers in the Arlington area fear that a major flood will bring this accumulated material down to their fields. In this regard, many farmers suggested that if the Gillespie Dam were removed, water movement would be facilitated and the Gila would cut its own channel.

Flood waters also threaten and sometimes damage other non-agricultural man-made features including gravel quarries, an elementary school near Arlington, the community of Allenville, and the Casey Abbott Semi-Regional Park. The community of Allenville was threatened by flood waters in January, 1966 and although little or no damage was done, the threat was serious enough to cause the evacuation of many residents. This same flood did damage to the golf course and picnic area at the Casey Abbott Park; the total cost of this flood in terms of lost greens fees and the labor required for clean-up and golf course repair is difficult to determine. However, even the minor floods that occur may cause the closing of Bullard Road, the park's major access route. This can result in a significant loss of income, especially if the flood comes during a winter weekend. Monthly income from the golf course ranges from a low of $5,480 in August to a high of $6,500-$7,500 in the winter months (1971 data).

Some major public values designated by the Bureau of Land Management in the Greenbelt (see page 2), would not be adversely affected and might be benefited in the long term e.g., nesting areas for white-wing and mourning doves. However, restrictions on a greater variety of public recreation in the future would probably not be improved and the need for further controls on flooding and erosion would be increased.

ENVIRONMENTAL IMPACTS OF A SIGNIFICANT DECREASE IN FLOW RATES

Hydrology

The present geomorphological conditions would essentially be maintained. Assuming no important change in pumping rates, the groundwater levels in the study area would gradually decrease. The concentration of total dissolved solids would increase, assuming that present irrigation practices continue essentially unchanged. Areas covered by surface water would probably decrease except for those maintained by sewage effluent and irrigation waste water.

Vegetation

A significant reduction in flood flow rates would affect vegetation primarily by a lowering of the groundwater table and a probable increase in salinity. A lowered groundwater table would reduce the density of vegetation in the floodplain. Surviving plants, particularly tamarisk, would also be much reduced in size. If flows resulting from runoff were restricted to narrow channels, the remaining floodplain vegetation away from the channels may eventually be completely lost except in areas where the groundwater table remains relatively high. Perhaps some drought resistant upland desert shrubs would then eventually become established in the dry floodplain.

Cattail marsh and open water would be reduced in area or replaced by tamarisk or other species except for those areas fed by Phoenix sewage effluent and irrigation waste water. An increase in salinity would tend to favor an increase in distribution of species such as saltbush and pickleweed in areas where irrigation waste water helps maintain a relatively high groundwater table and where relatively non-saline surface flows no longer flush the area. Impacts on plant species populations are indicated in Table 4.

Animal Life

A loss of cattail marsh, surface water and riparian vegetation habitat would have an adverse impact on the populations of many bird species, particularly resident and migratory waterfowl, and whitewing doves as indicated in Table 5.

There would be a similar adverse impact on non-bird vertebrates dependent on water habitat (Tables 6 through 8). The populations of some groups such as toads would be drastically reduced and some frog and fish species would be eliminated. Although most terrestrial species in the study area would probably show decreased population sizes, some species such as the desert iguana, which are adapted to dry environments, might increase in population size.

Archaeology

A significant decrease in the flow rate could have more adverse effects on archaeological sites than an increase in flow. If a significant decrease occurred, various forms of urban expansion and agriculture might utilize more land in the immediate vicinity of the ruin. Agriculture and urban expansion are the major sources of archaeological site destruction in Arizona today and this study area represents no exception.

Economic and Social

A significant decrease in flood flow rates would eliminate a substantial part of the flood damage potential to the agricultural, residential, industrial, transportational, recreational, and other facilities in the floodplain. However, an increase in groundwater salinity would have an adverse impact on agricultural productivity. A lower groundwater table would be similarly adverse although it might be beneficial in some areas where it is now close to the soil surface.

In general, conditions of low or no flow together with the assumed elimination of flood hazard, would almost certainly bring the areal expansion of permanent human use into the area. The stabilization of the flood plain with flow being confined to a relatively narrow channel, would probably result in the expansion of agricultural activity and perhaps dry land recreation, into the areas of present fish and game habitat. Agricultural and other lands, in turn, might eventually give way to residential and other intensive uses as the Phoenix metropolitan area expands.

A reduction in nesting habitat would be followed by a reduction in the whitewing dove population in the study area if sufficient alternate nesting sites and water were not available. This would tend to decrease the economic value of dove hunting in and near the study area.

APPENDIX A

Remarks for inventory of birds in the study area.

1. Although old records indicate nesting colonies of Great Blue Herons, none are known today. A colony of approximately 60 nests south of Avondale seen by Harry and Ruth Crockett early in the 1930's is our closest, most recent record.
2. The first nesting record for the Least Bittern in Arizona was from the Salt River, one mile east of its confluence with the Gila (Simpson and Werner, Condor, 60:68, 1958). Our recent investigations have disclosed breeding populations of this species from near Granite Reef Dam (Salt River) to Gila Siphon (near Yuma) on the Gila, in cattail and _Pluchea_-_Tamarix_ marshes.
3. The late Vic Housholder, a competent birder and collector who assisted with the construction of Gillespie Dam, noted American Bitterns along the Gila, especially at Gillespie Dam, in the winter of 1919.
4. Harry and Ruth Crockett found a single Roseate Spoonbill at Gillespie Dam, 6 July 1940, and three were seen there by Larry Toschik and son, September (1966?) (Arizona Highways, 11 March 1967).
5. A Wood Duck was shot at Palo Verde Marsh according to the owner, Mr. Osborn (Pers. Comm.), date unknown.
6. A single male Oldsquaw was taken one mile west of Arlington 14 February 1953, by Fleming and Swank.
7. A Goshawk was seen in heavy growth behind Gillespie Dam on 16 October 1955 (Simpson, Werner and C.T.Moore).
8. Cooper's Hawks may have nested here originally. They still nest upstream on the Salt River near its confluence with the Verde where large cottonwoods are extant.
9. At least two sightings of Rough-legged Hawks, each by several observers, are on record. Both were at Arlington Refuge, one 13 February 1955 (Abe S. Margolin and Maricopa Audubon Society), the other, 27 February 1953 (Johnson, _et al_.).

10. Although Harris'Hawks are not known to nest at present, they probably nested when large cottonwood trees were originally present as they still do on the Salt and Verde Rivers near their confluence and on Ft. McDowell.

11. The Clapper Rail has been recently found (3 June 1970) by Dick Todd, Non-game Biologist, Arizona Game and Fish Department and is a new addition to our Salt River Valley avifauna. It probably nests here.

12. Virginia Rails originally nested at Palo Verde Marsh (specimens in Johnson-Simpson-Werner collection, Prescott College).

13. Records indicate that the Sora possibly bred (breeds?) here at one time, according to Simpson and Werner, mid-1950's (Birds of Arizona, 31, 1964).

14. Phillips, Marshall and Monson (Birds of Arizona, 32, 1964) discuss the decline of the Common Gallinule in central Arizona as the marshes were destroyed. Sewage effluent and irrigation waste water in the Gila, and the resulting marshes and cattails, have allowed a strong comeback.

15. All specimens of the Stilt Sandpiper from Arizona are from the Salt River Valley, with a specimen from near Palo Verde (Birds of Arizona, 36).

16. Although the American Avocet is recorded in the Birds of Arizona as a non-breeder, we have recent nesting records from near Phoenix but not in the study area.

17. In the past the Black-necked Stilt has possibly nested rarely away from the Colorado River. (Birds of Arizona, 37). However, during the past few years it has nested regularly along the Salt River, upstream from its confluence with the Gila River and now may be nesting in the study area. If not, it is to be expected soon if present conditions prevail.

18. Our nearest specimen record of a Northern Phalarope is from one mile east of the study area but the species is seen on ponds and open water rather regularly during migration.

19. Coues saw a Bonaparte's Gull (or Gulls) "west of Phoenix" on the Gila River in the winter or spring of 1865. The species has been seen and collected in nearby localities.

20. Two Common Terns were seen at Palo Verde Marsh on 26 May 1955 by James R. Werner.

21. The fantastic population numbers reached by nesting White-winged Doves are discussed in numerous publications including the Birds of Arizona and (Wigal, Arizona Game & Fish Dept. Spec. Rept. no. 2, 1972).

22. Although Mourning Doves do not reach the high population densities of White-winged Doves, researchers have found concentrations of nesting colonies of approximately half the numbers of White-winged Doves. The two species nest side by side in dense salt cedar and mesquite thickets. This species gathers in large fall flocks with an estimated 10,000 individuals on a ten-acre plot near Palo Verde on October 16, 1955 (Simpson and Werner)

23. Screech Owls occur in the hills flanking the Gila River and in areas along other sections of the Salt and Gila Rivers. It is, however, possible that with the loss of the mesquite, there are insufficient large trees to provide nesting cavities for this species.

24. The records formerly showed this hummingbird (Anna's) to be a winter visitant but there are now nesting records from the Phoenix area.

25. A yellow-shafted Flicker was seen at the study area, right between the two rivers in mesquite thickets on 5 December and 13 December 1970 (Johnson and Simpson).

26. The Ladder-backed Woodpecker is restricted to riparian woodland in most of the Salt River Valley. This species can nest in smaller plants than the other two nesting woodpeckers. Thus, even though the Gila Woodpecker and Gilded Flicker prefer mature trees, such as cottonwoods, the Ladder-backed often utilizes saplings.

27. Although it would seem that Cassin's Kingbirds would pass through the Salt River Valley in large numbers when migrating from their breeding areas north of here to the south, and the other way in spring, two of our specimen records are from this area, one by Housholder and the other by Robert W. Dickerman. The only other additional record is from near the confluence of the Salt River with the Verde River.

28. The genus *Empidonax* is composed of several species of small flycatchers which are generally indistinguishable in the field, except possibly on their breeding grounds. Although we have made no intensive collections from the study area we have many collections of five species from the Salt River Valley. These are *Empidonax wrightii*, *E. oberholseri*, *E. hammondii*, *E. difficilis* and *E. traillii*. The respective common names are Gray Flycatcher, Dusky or Wright's Flycatcher, Hammond's Flycatcher and Traill's Flycatcher. These have all been collected within a couple of miles of the study area by Amadeo Rea as migrants. The only one which may have originally nested here is Traill's (both old and recent records from the Colorado and possibly the lower Gila).

29. A female Purple Martin that was collected from a small flock of migrating males and females (spring, 1971) is our only Salt River Valley specimen. The specimen was taken at the pond in the confluence of the Salt and Gila Rivers (Johnson and Simpson).

30. Housholder recorded one breeding pair of Ravens at Gillespie Dam, on a cliff (1919?).

31. The only known breeding locality of the Long-billed Marsh Wren, away from the lower Colorado River in Arizona, was Palo Verde Marsh (Simpson and Werner, Condor, 60:68, 1958).

32. We have a specimen of a Hermit Thrush from the study area. This secretive species is easily confused with the Swainson's Thrush (*Hylocichla ustulata*) which has been collected near St. John's by Rea, a few miles up the river, as well as further up the Salt by Johnson and Simpson and on the lower Gila River (netted by Russell, spring 1971).

33. We have wintering specimens of Blue-gray Gnatcatchers from upstream, along the Salt River. That species (*Polioptila caerulea*) is easily confused with the Black-tailed Gnatcatcher in winter.

34. The status of the Phainopepla in central Arizona is confusing, to say the least (see Birds of Arizona, pp. 139-140).

35. The dense growth in the river bottom serves as a haven for vast numbers of roosting birds in winter, as it serves for nesting of doves in summer. Johnson and Simpson estimated 16,000 Starlings left a single roost at the confluence on 29 July 1969 and 12,500 returned that evening.

36. This is one of the few areas in the Salt River Valley where Bell's Vireo occurs, in the *Pluchea* and dense *Baccharis* stands along water courses.

37. Although the Lucy's Warbler is one of the most common birds in certain mesquite thickets in the Salt River Valley, it is uncommon here. The same is true for some thickets upstream near Komatke, (Amadeo Rea). Concentrations of nesting Lucy's Warblers exceed five pairs per acre in prime habitat near the confluence of the Verde with the Salt River. We can not ascertain the reasons for this enigma, unless it is the loss of most of the mesquite on the Gila River.

38. We have collections of the Eastern Meadowlark from farmland near the study area. Eastern and Western Meadowlarks are so similar that few people can differentiate between them except by sound.

39. Yellow-headed Blackbirds have not been considered breeding birds of the area in the past (see Birds of Arizona, p. 165). Although we have no nests, bob-tailed juveniles at a pond at the confluence leave little room for speculation. Johnson and Russell also found previously unreported nesting Yellow-headed Blackbirds along the lower Gila River during their 1970 Environmental Impact Study for the Office of Arid Land Studies and the Corps of Army Engineers. Additional individuals migrate into the Salt River Valley in winter and roost with other "blackbirds" along the densely vegetated water courses. These Yellow-headed Blackbird populations have been estimated by some in the hundreds of thousands.

40. Red-winged Blackbirds also nest here and, like the previous species are joined in winter by additional winter vistants who number in the hundreds of thousands.

41. The Hooded Oriole has decreased in numbers, according to the few records available. It is the preferred host of the Bronzed Cowbird and the increase in numbers of that species may be a deciding factor in the decline of the Hooded Oriole.

42. The Boat-tailed Grackle is a recent "invader" of the area. Since their initial colonization of the Salt River Valley in the mid-1950's, they have increased in numbers and general distribution, occurring commonly where *Tamarix aphylla* and water, as well as livestock, are found.

43. The Brown-headed Cowbird parasitizes both species of orioles mentioned above. Although it is more numerous than the Bronzed Cowbird the Brown-headed Cowbird is often associated with a decrease in Hooded Oriole populations.

44. One of three state records for the sub-species *megalonyx* of the Rufous-sided Towhee is from Arlington (Birds of Arizona, 190).

45. The only Slate-colored Junco ever colledted by Alex Walker, 13 February 1932 at Palo Verde.

46. Six Gray-headed Juncos were seen at Robbins Butte on 4 December 1955 (Abe S. Margolin, James R. Werner, *et al*). This species is very uncommon in the central Arizona lowlands.

47. The avifaunal treatment for this study was accomplished in the short time allowed only through the able assistance and access to records of James M. Simpson, Prescott College.

APPENDIX B

Expenditures For Trips to Management Units 39, 41, and 42-Whitewings

Data For Trips to Management Unit # 39-Whitewing Only

Origins of Respondents (by county)	Number of Trips to Management Unit # 39	Number of Days (Total)	Total Number of People On Each Trip	Round-Trip Mileage to Management Unit #39 (per trip)	$ Amount Spent for: Lodging (per trip)	Food (per trip)	Other (per trip)
A	B	C	D	E	F	G	H
Pinal	1	1	1	50	0	5	3
Maricopa	1	1	3	40	0	0	3
	1	1	1	60	0	0	5
	1	1	2	5	0	0	6
	1	1	1	60	0	0	2
	4	4	1	60	0	3	13
	3	3	1	60	0	0	1
	1	1	1	60	0	0	0
	2	2	1	60	0	0	2
	1	1	1	60	0	3	3
Navajo	2	2	1	260	0	0	2
Total Management Unit # 39	18	18	14	-	$0.0	$ 11.00	$ 40.00

Data For Trips to Management Unit # 41-Whitewing Only

Origins of Respondents (by county)	Number of Trips to Management Unit # 41	Number of Days (Total)	Total Number of People On Each Trip	Round-Trip Mileage to Management Unit # 41 (per trip)	$ Amount Spent for: Lodging (per trip)	Food (per trip)	Other (per trip)
A	B	C	D	E	F	G	H
Yuma	1	1	1	185	0	0	7
	5	5	2	185	0	1	2
	2	3	1	185	0	0	2
	3	6	1	185	0	2	2
	2	2	3	20	0	0	1
	3	3	2	105	0	0	8
	10	10	1	50	0	0	1
Pima	2	2	1	385	0	0	4
Cochise	1	3	2	305	75	0	3
Coconino	1	1	1	425	0	0	2
Total Management Unit # 41	30	36	15	-	$75.00	$3.00	$32.00

Data For Trips to Management Unit # 42-Whitewing Only

A	B	C	D	E	F	G	H
Maricopa	4	4	3	105	0	0	5
	2	2	2	105	0	4	9
	1	1	1	105	0	0	4
	2	2	3	105	0	0	3
Total Management Unit # 42	9	9	9	-	$0.00	$4.00	$21.00

Summary; N = 25 Respondents

Management Unit	B	C	D	E	F	G	H
39	18	18	14	-	$0.00	$11.00	$40.00
41	30	36	15	-	74.00	3.00	32.00
42	9	9	9	-	0.00	4.00	21.00
Total	57	63	38	-	75.00	18.00	93.00

APPENDIX C

Data For Trips to Management Units 39, 41 and 42 Combinations

Data For Trips to Management Unit # 39 - Combinations

Origins of Respondents (by county)	Number of Trips to Management Unit # 39	Number of Days (Total)	Total Number of People On Each Trip	Round-Trip Mileage to Management Unit # 39 (per trip)	$ Amount Spent for: Lodging (per trip)	Food (per trip)	Other (per trip)
A	B	C	D	E	F	G	H
Pima	3	3	2	195	10	15	10
Mohave	3	3	1	420	3	8	8
Maricopa	3	3	1	60	0	0	0
	5	5	2	60	0	0	2
	4	4	3	10	0	0	1
	5	5	1	60	0	0	5
	3	3	2	60	0	0	2
	1	1	1	60	0	0	20
	2	2	1	60	0	11	13
	2	2	1	60	0	0	0
	1	1	1	60	0	0	6
	2	2	1	60	0	0	4
	14	14	1	60	0	0	1
	4	4	1	60	0	4	2
	1	1	1	60	0	3	0
	3	3	1	50	0	0	1
	5	5	1	60	0	0	6
	2	2	1	60	0	0	2
	1	1	1	60	0	0	1
Total Management Unit # 39	64	64	24	-	$13.00	$41.00	$84.00

Data For Trips to Management Unit # 41 - Combinations

A	B	C	D	E	F	G	H
Yuma	6	6	2	185	0	0	0
	20	20	1	185	0	0	5
	15	15	1	105	0	0	4
	17	17	1	185	0	0	2
Maricopa	5	5	1	110	0	0	1
	1	4	1	140	0	13	30
	5	5	4	140	0	0	0
Total Management Unit # 41	69	72	11	-	$0.00	$13.00	$42.00

Data For Trips to Management Unit # 42 - Combinations

A	B	C	D	E	F	G	H
Maricopa	4	4	3	105	0	0	19
	3	3	1	105	0	0	0
	2	2	2	120	0	0	10
	5	5	1	105	0	0	2
	4	4	2	105	0	0	5
	3	3	1	105	0	0	3
	2	2	1	105	0	0	1
Gila	25	25	1	180	0	0	1
Total Management Unit # 42	48	48	12	0	$0.00	$0.00	$41.00

Summary; N = 34 Respondents

Management Unit	B	C	D	E	F	G	H
39	64	64	24	-	$13.00	$41.00	$84.00
41	69	72	11	-	0.00	13.00	42.00
42	48	48	12	-	0.00	0.00	41.00
Total	181	181	47	-	13.00	54.00	167.00

APPENDIX D

Summary of Whitewing Dove Harvest Information, 1971

	Maricopa County	% of State	State
Hunters	26,142	57%	45,804
Trips	91,556	55%	166,429
Average trips	3.5		3.6
Licensed Harvest	204,324	53%	389,099
Junior Harvest	8,714	42%	20,695
Total Harvest (1971)	213,038	52%	409,794
Total Harvest (1968)	441,127		
Kill/trip*	2.2		2.3

Source: Arizona Game and Fish Department, Game Management Division, Arizona Game Management Data Summary, 1972 (preliminary draft).

* does not include Junior Harvest

APPENDIX E

INDIVIDUALS DIRECTLY CONTRIBUTING TO PROJECT

NAME	CONTRIBUTION
James E. Ayres Arizona State Museum University of Arizona	Archaeology
Lay J. Gibson Geography and Area Development University of Arizona	Economic and Social
Edward F. Haase Office of Arid Lands Studies University of Arizona Project Leader	Vegetation Compilation of Report
Simon Ince Civil Engineering and Hydrology University of Arizona	Hydrology
Jack D. Johnson Office of Arid Lands Studies University of Arizona	Project Advisor
R. Roy Johnson Environmental Studies Prescott College	Animal Life: Avifauna
Everett H. Lindsay Geosciences Department University of Arizona	Geology
William G. McGinnies Office of Arid Lands Studies University of Arizona	Project Advisor
Robert Ohmart Zoology Department Arizona State University	Animal Life: non-avian Vertebrates
Steven Russell Biological Sciences Department University of Arizona	Animal Life: Impacts on Avifauna

APPENDIX F

SELECTED REFERENCES

Arizona Game Management Data Summary (Preliminary).
1972 Arizona Game and Fish Department. 92 p.

Campbell, C.J. and W. Green
1968 Perpetual succession of stream-channel vegetation in a semiarid region. Arizona Academy of Science, Journal 5 (2) : 86-98.

Carr, J.N.
1960 Mourning dove and white-winged dove nest surveys during the summer of 1960. In Arizona Small Game Investigations, 1960-61-62, Arizona Game and Fish Department. 20 p.

Cottom, C. and J.B. Trefethan (ed.)
1968 Whitewings. D. Van Nostrand Co. 348 p.

Gary, H.L.
1965 Some site relations in three floodplain communities in central Arizona. Arizona Academy of Science, Journal 3 (4) : 209-212.

Gatewood, J.S., et al.
1950 Use of water by bottomland vegetation in lower Safford Valley Arizona. U.S. Geological Survey, Water-Supply Paper 1103. 210 p.

Green, C.R. and W.D. Sellers
1964 Arizona climate. University of Arizona Press, Tucson.

Haase, E.F.
1972 Survey of floodplain vegetation along the lower Gila River in southwestern Arizona. Arizona Academy of Science, Journal 7: 75-81.

Halpenny, L.C. et al.
1952 Groundwater in the Gila River Basin and adjacent areas, Arizona: A summary. U.S. Geological Survey open-file report. 224 p.

Harris, D.R.
1966 Recent plant invasions in the arid and semiarid Southwest of the United States. Annals of the Association of American Geographers 56 (3) :408-422.

Horton, J.S.
1972 Management problems in phreatophyte and riparian zones. Journal of Soil and Water Conservation 27 (2) : 57-61.

Horton, J.S., F.C. Mounts, and J.M. Kraft
1960 Seed germination and seedling establishment of phreatophyte species. U.S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station, Paper 48. 25 p.

Horton, J.S., T.W. Robinson, and H.R. McDonald
1964 Guide for surveying phreatophyte vegetation. U.S. Department of Agriculture, Handbook 266. 37 p.

Meinzer, O.E.
1927 Plants as indicators of groundwater. U.S. Geological Survey, Water Supply Paper 577. 95 p.

Phillips, A.R., J. Marshall, and G. Monson
1964 The birds of Arizona. University of Arizona Press, Tucson. 212 p.

Robinson, T.W.
1958 Phreatophytes. U.S. Geological Survey, Water Supply Paper 1423. 84 p.

Robinson, T.W.
1965 Introduction, spread and areal extent of salt cedar (tamarix) in the Western States. U.S. Geological Survey, Professional Paper 491-A. 12 p.

Ross, C. P.
1923 The lower Gila region, Arizona - a geographic, geologic, and hydrologic reconnaissance, with a guide to desert watering places. U.S. Geological Survey, Water-Supply Paper 498. 237 p.

Ross, C. P.
1921 Geology of the lower Gila region, Arizona: Shorter contributions to general geology. U.S. Geological Survey, Professional Paper 129-H.

Shantz, H.L., and R.L. Piemeisel
1924 Indicator significance of the natural vegetation of the southwestern desert region. Journal of Agricultural Research 28:721-802.

Shaw, H.
1961 Influence of salt cedar on white-winged doves in Gila Valley. In Arizona Small Game Investigations, 1960-61-62, Arizona Game and Fish Department. 9 p.

Shaw, H.G. and J. Jett
1959 Mourning dove and white-winged dove nesting in the Gila River bottom between Gillespie Dam and the junction of the Salt and Gila Rivers, Maricopa County, Arizona. In Arizona Small Game Investigations 1960-61-62, Arizona Game and Fish Department. 14 p.

Turner, S.F. and H.E. Skibitzke
1952 Use of water by phreatophytes in 2,000 foot channel between Granite Reef and Gillespie Dams, Maricopa County, Arizona. Phreatophyte Symposium. American Geophysical Union, Transactions 33:66-72.

U.S. Bureau of Sport Fisheries and Wildlife
1968 Rare and endangered fish and wildlife of the U.S. Bureau of Sport Fisheries and Wildlife Resource Pub. 34. 130 p.

Wigal, D.D.
1972 Nesting habitats of the white-winged dove in Arizona. Arizona Game and Fish Department Special Report No. 2 (in press).

Wilson, E.D.
1957 Geologic map of Maricopa County, Arizona. Arizona Bureau of Mines.