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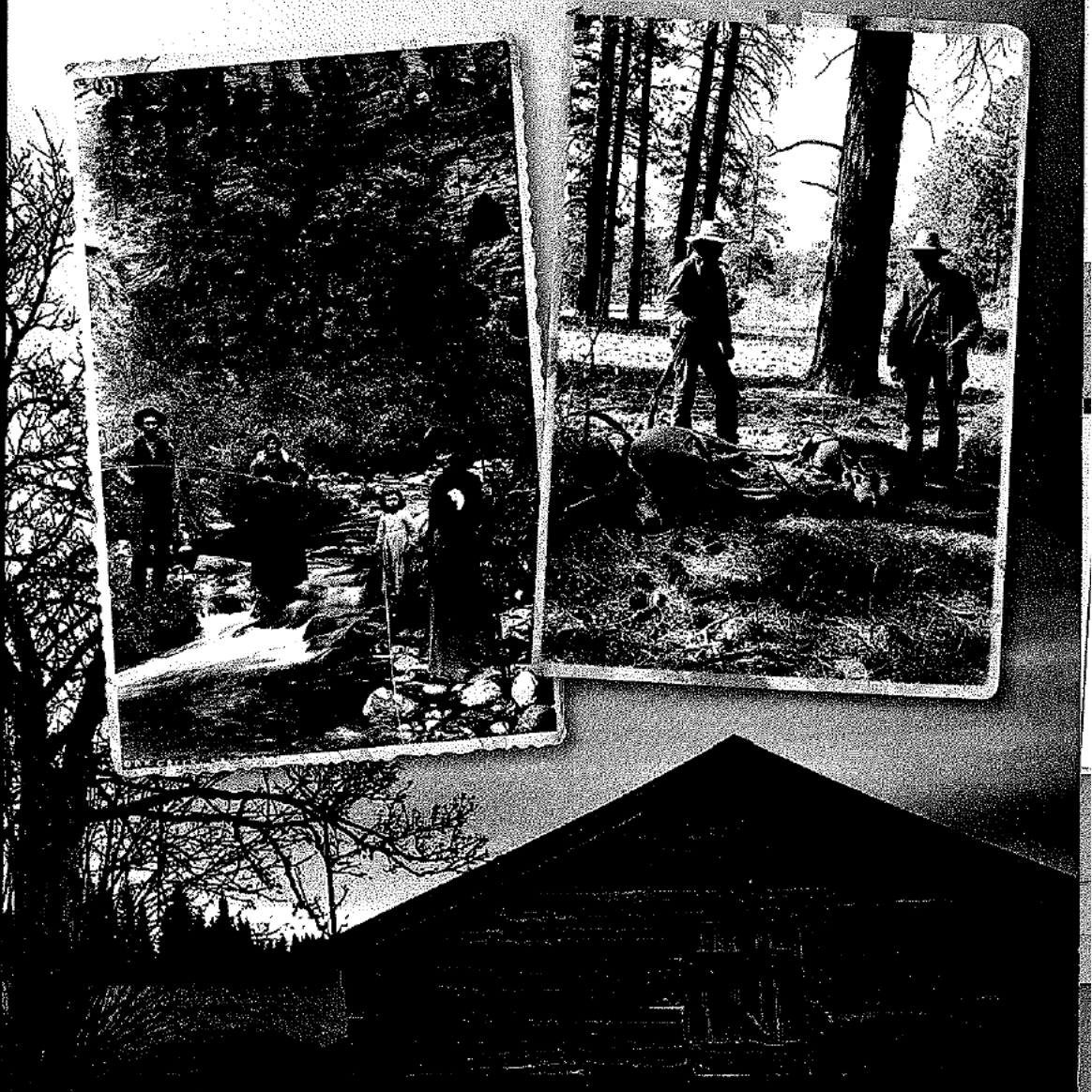
Arizona Wildlife

The Territorial Years | 1863–1912



David E. Brown, Editor

With Neil Carmony, Harley Shaw and W. L. Minckley

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The Military's Last Hurrah

Naturalists With the Wheeler Survey, 1871–1878

Neil B. Carmony

The Army staked out a huge area for the survey, covering most of California, Nevada, Utah, Colorado, New Mexico, and Arizona. The military surveyors would focus on measuring the landscape to produce accurate topographical maps; other survey members would collect a wide range of information on the geology, water resources, archeology, ethnology, and flora and fauna of the region. Officially titled *United States Geographical Surveys West of the One Hundredth Meridian*, the project was placed in the charge of twenty-nine-year-old First Lieutenant George M. Wheeler of the U.S. Army Corps of Engineers. Although Wheeler had supervised smaller mapping projects in California and Nevada, placing such a large undertaking under the command of a lieutenant shows just how hard rank was to come by in the tiny post-war Army of the 1870s.

The Wheeler Survey operated through 1878, but most of the biological investigations were made during the early years. Indeed, the activities of the survey's naturalists in Arizona were almost entirely limited to the summers of 1873 and 1874, although survey members had visited Arizona in 1871 and 1872. In 1871 Wheeler had led an expedition up the Colorado River from Camp Mohave (elevation 540 feet) to the mouth of Diamond Creek (elevation 1,330 feet) in the lower part of the Grand Canyon, a distance of about 240 miles. Accomplished by laboriously towing boats upstream with ropes, this bizarre investigation was seemingly designed to prove that Major Powell was not the only one interested in exploring the Grand Canyon region. Before returning to California, the party took a swing through central Arizona and visited San Francisco Mountain, the highest mountain mass in Arizona. It was on this visit that Wheeler and the brilliant geologist Grove Karl Gilbert named the highest point of San Francisco Mountain "Humphreys Peak" (elevation 12,630 feet) in honor of General Andrew A. Humphreys, chief of the U.S. Army Corps of Engineers.

The head of the Wheeler Survey's biological section during the years 1872–1874 was Henry C. Yarrow, an Army surgeon. The naturalists who made biological collections and observations in Arizona under Yarrow's

The Wheeler Survey reached Camp Apache in the White Mountains in August 1873. The camp was their base for five weeks as they made collecting forays into the surrounding mountains. The camp's designation was upgraded to fort in 1884, when this photo was taken. PHOTO AHS #24739 COURTESY OF THE ARIZONA HISTORICAL SOCIETY, TUCSON.

direction included Henry W. Henshaw, chief ornithologist for the survey and later (1910–1916) second director of the U.S. Bureau of Biological Survey; Army surgeon Joseph T. Rothrock, Wheeler's botanist; Army surgeon C. G. Newberry; and collecting assistant James M. Rutter.

Beginning in the 1860s, a number of military posts were established in Arizona and the Southwest (see Altshuler 1983). These small outposts of American civilization in the wilderness served for many decades as bases of operations for visiting naturalists. The officers at these posts were educated men and most were sympathetic to the goals of biological collectors. In fact, the collection of natural history information had long been a semiofficial function of military men stationed at remote locales. These camps and forts were a great benefit to visiting naturalists in that the post sutler could usually furnish supplies, and a military escort could be arranged if Indian raids were a concern. Working for the Army in the first place, the naturalists of the Wheeler Survey quite naturally made full use of the military posts in their collecting efforts.

continued on past Camp Apache, reaching the Gila at the same point as in 1873, and then on to Camp Grant, arriving there on July 28.

Rothrock, the botanist, had been favorably impressed by the landscapes of the White Mountains, the conifer forests, meadows, and live mountain streams, but as the naturalists dropped down to the Gila River the vegetation changed dramatically. Rothrock noted that "a marked change comes over the scenery as we go south. One by one the familiar forms of plants disappear, and in their stead we have the mescal [agave] . . . , mesquite . . . , creosote-plant . . . , [ocotillo], and giant cactus. . . . A more forlorn-looking vegetation can hardly be imagined" (Wheeler 1875b).

Cottonwood trees of fair size grew abundantly along the Gila, where, "with willows, bulrushes, and the large reeds, an almost impenetrable thicket is formed" (Wheeler 1875b).

Camp Grant was situated at the western base of Mount Graham (highest point 10,710 feet), and the naturalists spent a week making collections on the mountain, from its base to its conifer-clad summit where the Army had established a small lumber camp to the southeast. A hard day's march took them to Camp Bowie at the northern end of the Dos Cabezas Mountains. From August 6 to August 19 they worked out of Camp Bowie and explored some of the higher-elevation habitats in the Chiricahua Mountains (summit elevation 9,800 feet).

A rapid march to the west brought the men to the southern portions of Sulphur Springs, about five miles southeast of the southern end of what is today known as Willcox Playa, a large dry lake. Rothrock described the springs:

> Sulphur Spring, twenty-five miles west of [Camp Bowie] . . . and fifteen east of the Dragoon Mountains is likewise an important location, from its abundant supply of good grass. Before reaching it the road for miles lay through a dense growth of sacaton-grass, which was of infinitely less value than the shorter grama that fairly covered the ground at the springs. Without exception, this was the best location for this we had seen. Associated with it were a number of other species of scarcely less value. The water is warm, but sufficient for grazing purposes (Wheeler 1875b).

Frederic Morton Chamberlain's 1904 Fish Survey of Arizona

Edited and introduced by W. L. Minckley

A previous version of the following chapter was published in the Summer 1999 Journal of the Southwest *[Volume 41, No. 2] and is reprinted here, as intended by the late Dr. Minckley, with permission of the editor, Joseph Wilder. The manuscript has been lightly edited and some passages rearranged for clarity. The serious student of Arizona's native fishes will want to check the original journal article to read all of Minckley's annotations and references.*

Although a number of fish had been collected on the various biological surveys in Arizona, it wasn't until 1904 that a bona fide aquatic biologist, Frederick Morton Chamberlain (1867–1921), conducted a systematic fish survey in Arizona Territory. Chamberlain was an assistant with the U.S. Fish Commission (after 1903 called the U.S. Bureau of Fisheries, evolving over time into the fish portion of the U.S. Fish and Wildlife Service) from 1897 to 1914. His assignments were diverse and geographically widespread (Jennings 1987). He surveyed freshwater fishes in rivers tributary to the Gulf of Mexico, studied salmon fisheries in California and Alaska, collected thousands of oceanographic records and biological specimens as a naturalist aboard the *U.S.S. Albatross* in the north and central Pacific, and assessed fur seal populations in the Pribilof Islands.

In 1904, Dr. Barton Warren Evermann, then director of the Division of Scientific Inquiry, U.S. Bureau of Fisheries, and Chamberlain's former mentor at Indiana State Normal School (now Indiana State University), commissioned Chamberlain to perform a survey of fishes in Arizona Territory. The resulting excursion from January 15 to April 28 included about thirty days in the field, concentrated in the Gila River basin. Most were in well-traveled parts of the territory, likely because of insufficient time to access more remote areas. Chamberlain nonetheless made collections and natural history observations at more than twenty locales, reported in a handwritten, fifty-two page manuscript housed in the Smithsonian Institution Archives. This manuscript was reproduced in toto in the summer 1999 issue of the *Journal of the Southwest* (41(2): 177–237) along with my annotations and comments. The following

passages, reprinted here with permission of the Arizona Historical Society, repeat Chamberlain's report nearly verbatim except for some detailed fish descriptions and a listing of Chamberlain's metal fish tags. Serious students of Southwest fishes will nonetheless want to consult the original journal article as it contains numerous detailed annotations regarding fish history and status.

Chamberlain's observations and reports of firsthand testimony on failing springs, declining water tables, and floodplain incision are pertinent, as are the numbers and species of fish recorded. His attribution of environmental deterioration from the collective abuses of overgrazing and other unwise agricultural practices, the overcutting of forests and woodlands, the pumping of groundwater, mining spillages, and possible climatic change, was shared even then by the people he interviewed. Perhaps the most significant single contribution of his report, however, is to dramatize the magnitude of change. Many recognize the vastness of environmental alterations in Arizona, yet only a few specialists appreciate the disparate severity of these impacts on its original aquatic systems. More than half of the sites and stream reaches (fourteen of twenty-two) visited by Chamberlain in 1904 are now dry except in flood or are otherwise so drastically modified that native fishes are either significantly reduced in numbers and diversity, or extirpated. Of the sixteen native species caught by Chamberlain, one is extinct, and eight are listed as Threatened or Endangered by the U.S. Department of the Interior.

ITINERARY

Reach Yuma, Ariz., Jan. 15.

Work on Alaska Report to Feb. 26.

Fish Colorado River at Yuma, Feb. 27.

Reach Tucson, Feb. 29.

Work on Alaska Report to March 26.

Fish Santa Cruz River at San Xavier, March 27 and 29.

Leave for Patagonia, Apr. 1.

Fish Sonoita Creek and Monkey Spring, Apr. 2.

Visit Monkey Spring, Apr. 3.

Fish Santa Cruz River at Nogales, Apr. 4.

Fish San Pedro [River] at Fairbank, Apr. 5.

Fish San Pedro River at Charleston and Babocomari Creek, Apr. 6.

Reach Safford, Apr. 7.

Fish Ciénega and visit Gila River at Safford, Apr. 8.

Reach Clifton, Apr. 9.

Fish San Francisco River, Apr. 11.

Fish K.P. Creek, Apr. 12.

Fish Blue Creek [River], Apr. 13.

Fish Gila River above Duncan at the "box," Apr. 14.

Fish Gila above Duncan and at Coronado, Apr. 15.

Reach Globe, Apr. 16.

En route to Payson, Apr. 18 and 19.

Fish Tonto Creek at cañon, Apr. 20.

En route to Fossil Creek, Apr. 22.

Fish Pine Creek at Natural Bridge and East Verde River at Angora, Apr. 23.

En route to Cline, Apr. 24.

Fish Salt River at Roosevelt and Tonto Creek near mouth, Apr. 25.

Fish Pinal Creek, Apr. 26.

Reach Tucson, Apr. 27.

Leave for Alaska, Apr. 28.

COLORADO RIVER [STATION I]

The Colorado was seined at the mouth of the Gila channel. Temperature in backwater was 65° F. This backwater extends from the Colorado up the Gila channel for nearly a mile. It is entirely from the Colorado water as the Gila is dry above at all but flood seasons. Water is 6 inches to 3 feet deep; mud about equally deep, apparently resting on a firmer bottom. The channel is somewhat trough shaped, deepest in the middle in most places.

Three [seine] hauls were made with a 45 ft. net, two hauls about 50 and 100 yds. [in length], respectively, above the Colorado in shallow water, perhaps not over two ft. at deepest, surface width about 100 ft. Results: mostly small carp and catfish, a few small bony-tail, and humpback sucker, the first two species very abundant and the carp in excess, about 100 of the latter in a haul, mostly 5 to 7 in. total length. Third haul made just inside on the island side, water deeper. In this haul the fish averaged much larger, in addition to the carp, cat, and

pools among these rocks were full of *Agosia* apparently trying to ascend. No other species were seen in the creek.

Below the cañon the channel expands and the stream becomes wider and shallow, seldom exceeding 6 or 8 in. in depth, over sandy bottom. About a mile down is an irrigation dam diverting all the water. The pond formed is 5 or 6 ft. deep and about 60 by 150 ft. in extent. I could not seine it. It is said to contain suckers but I could not see any. Water 70° at 4 P.M. clearer than San Pedro water and less alkali.

This entire region is subject to the causes of decline mentioned above. Aside from the backwater above the dams there are no pools of size for edible fish, the water passing over riffles and flats becomes very warm, cattle eat and tramp out the plants, while dams prevent migratory movements.

It is rumored that catfish are found in water holes below Benson. They are not known above. At Huachuca, above Fairbank, are some springs and marshes said to contain fair sized chubs (*Leuciscus*) in some numbers. I did not examine them.

GILA RIVER [STATIONS X, XI, XII, XIV, XV, XVI]

AT SAFFORD

The cañon about 15 mi. above Duncan [Station XV] is the uppermost point at which the Gila River was examined. This cañon or "box," visited April 14, is said to be about 7 mi. long, with a farming (irrigated) district some 15 mi. in extent above it, which in turn is followed by another cañon.

The part of the cañon examined is 60 to 100 yd. wide with rocky walls in places perhaps 100 ft. high. The channel averages about 50 ft. in width, the stream 10 to 50 ft., and up to two feet in depth. The water somewhat alkaline and had a temperature of 78° F. at 2 P.M. The "Sunset" Dam at the lower end of the box takes practically all the water. No plants were noted except algae, which are plentiful in the stream and ditches. A few schools of *Agosia* were the only fish seen. Hauls in a good pool near the lower end of the cañon were water hauls, as was also a haul in main ditch. It is said that good fish formerly ran out with the ditches where they were caught by children. No seines were ever used. This may have helped to hasten the depletion of the stream.

A number of dams span the channel between the cañon and Duncan. These dams are built of brush and sand and go

out with the first rise. They are put in as early in the spring as practicable and stand during the rainless summer. The river is practically dry below each one, accumulating head enough by seepage to fill the next in succession. When the sand is deep over bed-rock the river "sinks" and is dry, the amount of water varies directly as the approach of bedrock to the surface. Near Sheldon [a former site in Greenlee County] the bed is of rock and there are likely looking pools. I did not examine them. Between there and Duncan the river is dry.

In pools above Duncan and below the box only *Agosia* was found. Suckers are said to have been plentiful up to two years ago, and salmon some years earlier. Catfish are also reported, they are said to have come from a broken pond on the ranch of Lyons and Campbell in New Mexico. Hardshell turtles [Sonoran mud turtle] were seen but could not be secured. A softshell was taken. These latter are said to be not rare. They may have been flooded over at the same time with the catfish.

In the shallow pools in the stretch above Duncan the current is so slight that the algae near the bottom decompose giving the water a foul odor. The growth is very copious.

At Coronado [a former site in Greenlee County], 20 miles below Duncan, examined April 15, the stream is larger, with a few fair looking pools [Station XVI]. I could not seine these but tried a small charge of powder in two of them with no result. There are doubtless no fish there with the exception of *Agosia*, the fry of which could be seen in places. A sort of *Myriophyllum* was growing there in small quantity. Children report having seen a few suckers in pools not far above toward Sheldon.

The river flows over a rocky or gravelly bed with pools of fair depth for a few miles below Coronado, where it is joined by the San Francisco [River]. I did not see it below this, but not far below, the Montezuma Dam [now called the San Jose diversion dam in Graham County] diverts nearly all if not quite all the water. When this ditch water reaches Solomonville it is thick with the concentration sediments. It is probable that fish would not live between the mouth of the San Francisco and a point below where the water had become purified, perhaps below Solomonville [now Solomon].

From the point of junction to above Sheldon native fishes

might survive under favorable conditions. A plant of black bass is said to have been made in this stretch in recent years (delivered to Wiley Jones at Solomonville perhaps). They probably did not survive the first flood.

At Safford, April 8, the river was examined [Station X]. The ? Dam lies two or three mi. below Safford. It was not examined, but is said to divert all the water. The "Central" dam about one mi. above Safford is of construction similar to those near Duncan described, except that boulders have been used in its construction leading to more or less permanency with the result that the channel above has been filled with sand and the bed thus raised to a level with the boulder substratum, about two ft. The entire dam is about four ft. high, diverting almost the entire stream into the ditch, about 80 in. of water [2.0 cfs]. The water here is clear, the Montezuma ditch removing all the concentration sediment [from upstream mines].

Below the dam the water again accumulates and a short distance below, perhaps ½ mi., the stream averages 20 ft. wide and three ft. deep, with a very slow current over a fine sandy bottom. A heavy growth of green algous slime lies on the bottom. The channel is 100 to 150 ft. wide and about 10 ft. below the general level, with heavy washes of sand banks in places. Water temperature at 3 P.M. 82° F. No sign of fish life visible. As there are no pools I did not seine.

Several years ago fish were abundant. Then pools of sufficient depth for men to swim in existed. Salmon reached a weight of 35 lb., humpbacks and other suckers were common. None of these fish has been taken in the last two years. It is believed that minerals and concentrate wash from the mines and works at Morenci and Clifton have killed the fish. In evidence of this is cited that fields irrigated with this wash will not grow certain plants as pumpkins and beans. I think it probably that these have had little or no causative influence in the matter as other causes are sufficient to account for the change.

The Gila as seen at San Carlos in crossing [April 16] shows the same characters as at Safford.

CIENÉGA SPRING

About 9 mi. south and west from Safford is a spring [Station XI] flowing about sufficient water to fill a two in. pipe under a

[Sonora topminnow]. Bonytail [chub] was more abundant in the pools, *Agosia* shallower places. All the *Meda* and "bonytail" suckers [flannelmouth suckers] were saved. *Poecilia* were found to be with well developed young almost ready to deposit. This species was remarkably abundant in the outlet of a warm spring near the town. [This spring still flows from cliff faces on the west side of the river immediately downstream from the dam.] The water at the outlet of this spring was 108°, but somewhat cooler where the fish were. There is also a small frog and a great number of tadpoles of large size in this warm water.

PINAL CREEK [STATION XXII]

This stream flows into Salt River from the south. It is a small stream, dry in its upper course, but rising just above the crossing of the Payson road [Station XXII], a few miles above its mouth. It carries only about 25 to 40 in. of water [0.63 to1.9 cfs] over a fine gravelly bed at the point examined. The only fish found was *Tiaroga* [actually speckled dace, *Rhinichthys osculus*], which was taken with a hand dipnet. There is no vegetation in the stream. Below the road the creek enters a rough cañon and probably increases more or less in size.

To complete this examination it had been my intention to visit such streams as could be reached from the connecting road through Phoenix, getting topographic data at Phoenix for the whole region. The upper waters of the Verde are accessible from Jerome. A further study of the White Mountain region should also be included.

DISCUSSION AND SUMMARY

The general causes of extinction of fish life now operative in this region may be outlined in this manner:

1. Destruction of vegetation (cattle ranching, etc.).
   a. Increased Floods
      1' Diminished volume of streams during dry seasons
      2' Increased erosion
   b. Increased Erosion
      1' Filling in of pools
         a. Destruction of places of refuge
         b. Destruction of food, plant life

c. Increase in range of temperature
2' Rendering water unfit for respiration
3' Change of climate—?
2. Irrigating operations
a. Use of water
b. Prevention of migration by dams
c. Destruction of fish in ditches
3. Mining operations
a. Use of powder in destroying fish
b. Drainage of sediment from mills
Injurious chemicals in ores or processing

1. Ranging [Ranching] has destroyed the herbage. Primitively the mesas were covered by a protective growth of grass and herbage. This during the rains reached a height of two ft. or more. Upon return of the dry season it died but formed with the roots a mulch and a barrier to erosion. Since the introduction of herds this growth is not only eaten short but trampled out of existence to a greater or less extent over all that region within a radius of daily movement from water. Only at considerable distance from any source of water is the growth undisturbed. Cattle range 10 or 12 miles, horses and burros further. This denudation leads to - 1st, increased floods, 2nd, increased erosion, and 3rd, perhaps to climatic change.

The water falling on bare ground is not taken up by the soil but runs off rapidly causing more rapid and greater rises in the streams and proportionately longer periods of drought since what would be the permanent water has drained away all at once, hence there is a greater and a longer depression of value to the streams. This increased flow causes greater erosion on account of the greater velocity of the wash. 2nd, the bareness of the ground allows vast quantities of material to be carried off. This sediment affects fish life detrimentally in two ways: 1st by filling up the channels and obliterating the pools, 2nd by rendering the water unfit for respiration at the time of its complete saturation.

The filling up of pools destroys the places of refuge of the larger fish—their habitation, allowing them to become prey of all animals that desire them. It induces them to run out into

ditches where they are lost, and to leave the stream by its regular channel. It destroys the natural vegetation by destroying the habitat of species that require cooler, deeper, and quieter water, by covering and killing plants growing at the margins of the stream, by making all parts of the channel subject to the trampling and feeding of cattle.

It increases the range of temperatures by spreading the waters in a thin sheet and subjecting it thus to rapid augmentation and loss of heat from the sun and atmosphere. This renders the water uninhabitable by its high temperature, perhaps increasing disease, and also increases the amount of evaporation.

The destruction of trees for lumber and wood has added to the effect of loss of smaller plant growth. The growth of cottonwood and other timber has been cut for lumber, mining fuels, and in some instances for the feed afforded by the foliage. For fuel it is carried out of the more inaccessible places by burros.

The water of the streams is said to become almost thick with silt during the floods. Fish in numbers are seen floating in the turbid areas, apparently gasping for breath. Even if not killed by this excess of suspended matter, they may be stupified to loss of control and drift out on the banks to die, or are carried to the lower courses where in a less rapid current the water clears up to a living condition, and whence they may not return over the dams. Or previous times the distastefulness of such waters may lead the larger and more powerful fish to seek more agreeable regions.

Climatic changes seem to be following this denudation of the country. The last three or four years are spoken of as years of increasing drought. Ranchers everywhere insist that 'Arizona is drying up.' In many places, as the Tonto Valley, once prosperous farms have been abandoned.

2. Irrigation operations affect the fish life primarily by the consumption of the water. Once diverted from the river it is expended on land and lost by evaporation. Only the depth of bedrock prevents the extinction of the smaller streams in their upper courses, but in the sand lying above, a seepage occurs that renews the stream successively above each dam, until the

amount of water remaining is within the capacity of the sand layer to carry it beneath the surface. At this point the stream is dry and water can be obtained only by digging. In these 'wells' fish are sometimes found, but I could not determine whether they were surface refugees from the gradual seasonal drying up or whether they might be able to exist in the sand in cavities and find liberty—later—in pools formed by the 'well.' This absorption of water sometimes leads to the curious reversal of natural conditions and streams may be larger nearer their source.

Irrigation dams are for the most part temporary structures put in year by year after the rains. In almost all cases they present a barrier to the ascent of all fish thus shutting off any increase of supply from the permanent waters below or above. Those from below can not climb over the dam, those from above follow out into the unscreened ditches and are lost in the fields.

3. Mining operations are perhaps accountable for the depletion to some extent. 1st because the almost universal familiarity with powder has led to more or less destruction in that way. (In my experience not one-twentieth of the number of fish killed by powder can ordinarily be obtained. A general belief obtains that they rise after such death. This is true only of such fish as have life enough remaining to struggle as when the drift of the current 'boils' them up. Hence in collecting it is best to use powder in pools with strong bottom currents, as beneath falls, of when by subsequent clearing of the water one can see his results on the bottom. The sediment from concentrating mills, as at Clifton, rapidly fills up river channels. It has the effects in a much less degree already noted under the heads of floods and erosion.

Perhaps the most remote effect is the action of poisonous compounds. Enough poisonous material might escape at times to have an appreciable effect either in the normal operation of roasting copper ores, or from abandoned cyanide processes. I saw no instances when I thought this cause operative.

So long as the present climatic conditions remain, and the existing industries are prosecuted, I can see no means of restocking these streams. The execution, if it were possible, of limiting laws for the trout streams might save them. The

streams of the White Mountain region are beginning to attract the attention of anglers from towns like Clifton and Safford, who may perfect this sport. The usual method of catching trout, as pursued by residents, is by the means of the eye as bait. The first fish is taken in any possible manner, the eye is then extracted for the next so that each fish furnishes means for capture of his fellows. Catches of 200 are reported for a single line. Of course they cannot long survive such vigorous onslaughts in the little streams which they inhabit.

Plants of various kinds have been made in the streams at times, but I could hear of no results. The planting is sometimes left to an uninterested person who is anxious to avoid the long and tedious drive with its attendant cans to a proper point for depositing the fish, and the trips are thought to have been in some cases unduly shortened. The Aravaipa has been suggested to me by Mr. Holsinger as a stream worth stocking. I had no opportunity to see it, but from description of a recent visitor I suspect it of doubtful value.

The only hope for fish in this region lies in pond culture. Not infrequently, springs, wells, mountain brooks or such supplies furnish opportunity to grow fish. In a few cases it is being done, but otherwise intelligent men seem often—if not usually—to think a pool of water, a small fish, and a brief time the only conditions for a good catch. Ponds are usually overstocked both in numbers of individuals and number of species. If the recipients of stock fish could be given a few plain rules for the preparation of their ponds and care of the fish, especially if they could be made to understand that not only does the growth of fish depend on food supply to an even greater extent than in the case of other stock, but that their survival is a question of abundant food, they should perhaps attempt fewer fish in small ponds or arrange for feeding. With a more general knowledge of pond culture the necessary natural depletion of Arizona streams may be viewed with equanimity.

Respectfully submitted
[signed] F. W. Chamberlain
Asst. Bur. Fish.

three thousand specimens of mammals, birds, reptiles, and fish. Frank Stephens, a professional collector and an experienced Southwest desert naturalist, was his assistant (Huey 1938).

Grinnell's study as well as Sykes' (1937) later explorations of the lower Colorado River Delta are somewhat unique in that both investigators were able to view the Colorado as a natural river, still going to the sea, still characterized by an enormous amount of cutting and deposition. Grinnell noted that the amount of sediment carried in suspension was always very great, so that the flowing waters were quite opaque at all seasons of the year. Furthermore, the river varied enormously in volume, both throughout the year and between years. Flows varyied from four thousand to one hundred thousand cubic feet per second, the river's depth ranging from zero to twelve feet depending on the time and location. Generally, the period of low water was in midwinter; high water occurred from May 15 to July 1. Given the great fluctuations involved, Grinnell found that the river had been a poor barrier and had only a modest effect on species distribution.

By studying the variation in flow, Grinnell was able to observe the areas of sedimentation and erosion, the river possessing distinctive "first" and "second" bottoms. Like other free-flowing rivers in the Western Hemisphere that flow from north to south, the Colorado tended to cut or erode its western banks and to slow down and deposit silt on its eastern. The sedimentation was the driving force, causing the river to meander across the generally level plains, the constantly shifting channel periodically tearing out rapidly growing trees such as willow and cottonwood that had become established only a few years before. Grinnell also observed that where the river had cut off meanders and formed still-water lagoons, the latter were characterized by high evaporation rates and halophytic deposits.

Grinnell's trip took place during a time when dam building was only beginning to have a noticeable effect on the river. Laguna Dam, completed in 1909, was the first dam on the lower Colorado. While too small to control the river, it nevertheless had a pronounced modifying influence on its flora and fauna. The dam rose to only twelve feet above the river's mean level, and by May 10, 1910, sedimentation had filled it in. The effects of flooding were apparent for thirty miles above the dam. Not only had floodwaters deposited their loads of silt above the dam, they

had all but drowned the riparian vegetation upriver. Below the dam, the reverse took hold: the overflowing river, running faster, had more cutting power and deepened the channel.

Dividing the plant communities along the river into six riparian associations and five desert associations, Grinnell found that the Colorado effectively restricted the distributions of only eight small rodents—two ground squirrels, two gophers, three pocket mice, and another mouse. Some of these "subspecies" separated by the Colorado River were as close as 850 feet, showing that isolation does facilitate evolutionary change, and that the differences observed relate to the degree and time of isolation. More important than the river, he observed, were the effects of isolation by plant association, some animals being highly restricted to particular plant communities. He also noted that the occurrences of southern forms appeared to then be ascending in frequency while boreal forms were in decline—a situation still occurring today. His wildlife inventory is therefore important and as relevant today as in 1910.

A comparison with present conditions appears to show that riparian species such as tanagers and orioles were better represented in Grinnell's day than now. Wood ibis, a rather uncommon species on the river today, was reportedly common. Few ducks were seen during Grinnell's visit, although "cranes were seen daily." These birds were then using the river's sandbars to roost, just as is the case where these features remain today. No major changes in bird migration patterns are evident, however. For example, he noted the first white-winged doves on April 29 at Potholes (opposite Laguna Dam) where they were common in dense riparian vegetation.

Bighorns were of course present, then as now, on both the Arizona and California sides of the river. Interestingly, Grinnell thought that there was only a possibility that the "burro deer still exists" in that no trace of the animal was found, and he was told that no one had reported any for four years. Desert mule deer are now rather common at certain places along the river as at Cibola National Wildlife Refuge.

Despite the lack of deer, cougars were still present, as footprints were seen four miles below Potholes along the main river channel. Grinnell also purchased two skins and skulls of male lions from a rancher eighteen miles north of Picacho. Both of these lions had been feeding

After spending a day at the XXX, they continued on to their ranch on the Blue, the Y-Y:

> The next day, we packed up and went into the ranch. It didn't look like the same place, at all. Out in front of the creek was a big bottom with timber on it—a pretty stream down there. There wasn't a tree left on the flat—it took them all.
>
> It [Blue River] will never be the same again. It was a good road all the way down there. The pass was all covered with timber and the road was cut through the timber. It was a pretty drive from here to Clifton. And the creek was just a narrow channel that would go off and out on the other side. My Dad would hook up to the buggy and leave the ranch up there and trot down to Clifton in about seven or eight hours. If we had had cars in those days, or if this road now was like it was in those days, you could go from the ranch to Clifton in 45 minutes or an hour. The only place you slowed down was going off the bank, crossing that creek channel.

What changed the Blue, and most all of Arizona's streams, was the process known as arroyo- or channel-cutting, by which the stream erodes a new channel that is incised below its banks. Although obviously the results of flood events, the hydrological and geomorphological causes of arroyo cutting have yet to be fully explained. Most observers consider the destructive flooding that occurred between 1891 and 1915 to be due to increased runoff on the overgrazed landscapes, but just why the water cut down to lower levels is not so easily explained, some investigators such as Kirk Bryan (1925) thought the drought to be responsible, and that livestock grazing only "pulled the trigger" on floods that were destined to initiate a new erosion cycle. Others, such as Cooke and Reeves (1976), attributed the incised channels to flood waters deepening wheel ruts and other human-caused erosion features. Whatever the actual cause or causes, the onset of serious arroyo-cutting in Arizona began about 1881 and continued until 1909 or thereabouts. Because of Tucson's location astride the Santa Cruz River, flooding and channel cutting were especially well documented there (*Tucson Star*, Aug. 8, 1890). In 1890 and in the months and years that followed, arroyo-cutting was reported on Rillito Creek, the San Pedro River, the San Simon River, and other southwestern drainages as far west as the Rio Sonoyta south of Ajo (Lumholtz 1912, Turner et al. 2003).

The San Pedro River in 1870 was reportedly nearly level with the surrounding flood plain and marshy in nature, the stream often forming ciénegas. By 1892 or 1893, however, a gully from three to twenty feet deep had been cut for 125 miles along its course. By 1900 this gully had entrenched downward from ten to forty feet, which drained most of the marshlands resulting in much loss of aquatic life (Bryan 1925, Thornthwaite et al 1942, Miller 1961).

Many stream channels were not only deeper but also wider. Olmstead (1919) and Ross (1923) speaking of the Gila River near Safford described the bottom lands as having become "desolate wastes of sand and silt," and Bryan (1925) reported the Gila's redefined channel at Solomonville as having an average width of more than 1,900 feet. This same stretch of river had an average width of 138.6 feet in 1875. Similarly, the narrow San Simon River's sixty or so miles in Arizona were originally clothed in sacaton grass and possessed many artesian waters (Olmstead 1919). But an early ditch constructed in 1883 resulted in a head cut that so entrenched this river that by 1935 its channel had cut down ten to thirty feet and the stream's banks had expanded in width to several hundred feet. All of the riparian trees had been eliminated (Barnes 1936).

The Blue River valley, where the Cospers lived, was well settled by 1885 and its cultivated bottomlands had an average width of seven hundred feet. Beginning about 1900 a series of floods incised and widened the channel, until, by 1916, the alluvial bottomland and riparian forests downstream from K-P Creek had virtually disappeared leaving only about 8 percent of the original arable land remaining (Olmstead 1919, Bryan 1925).

Nor was northern Arizona unaffected. Sitgreaves wrote in 1853 that the Little Colorado River, originally named the Rio Alameda for its gallery forest of cottonwoods and willows, contained extensive swamps (and elk) above Winslow. At about the same time, Whipple (1856) stated that "the river is about 30 feet wide flowing between alluvial banks eight to ten feet in height. . . . The banks of the main stream . . . are sprinkled with cottonwood trees . . . the river bottom is in some places marshy, with willow thickets, and in others covered with a loose pulverized soil."

As late as the 1880s, the Little Colorado remained a narrow perennial stream, its banks lined with old and young cottonwoods. Many beaver were present and grama grass covered the adjacent hills. But all had changed by the 1930s. The river was now normally dry between Winslow

and Holbrook, the trees replaced, if at all, by tamarisk. The grass was gone, and when the river did flow, it was along a wide, barren valley where its sandy bed was wide and deeply entrenched (Colton 1937).

Similar descriptions are available for Kanab and Tonto creeks, the Santa Cruz River, and virtually every stream where cultivated agriculture was practiced along its banks. The effects of these phenomena on riparian animals were profound. By 1912 many game and fur-bearing species formerly found along the territory's stream-ways had been locally extirpated.

The widespread flooding and arroyo cutting that preceded statehood brought about one other wildlife casualty. Natural lakes being almost nonexistent in Arizona Territory and large reservoirs yet to come, farmers and irrigation companies had constructed a number of stream impoundment structures in the 1880s. Although the primary purpose of these impoundments was to provide water for irrigation and/or flourmills, many of them possessed significant recreational value, especially for fishing and duck hunting. Some of the structures and impoundments, such as Laguna Dam, built across the lower Colorado River in 1909 and Casa Grande (later Picacho) Reservoir on McLellan Wash, were expansive and of long duration. But most were of short-lived and are now all but forgotten (Brown 2003). Examples included Zion Reservoir on the Little Colorado River, Peoria Reservoir on the Agua Fria River, and Silver and Warner lakes on the Santa Cruz River. Floods destroyed them all during the territorial period. The history of two of these, Silver and Warner's lakes, was chronicled by Bettancourt (1989).

Silver Lake was several acres of impounded water created by a masonry dam on the Santa Cruz west of Tucson. It was first dammed prior to 1860 and improved upon in 1881. Warner Lake, downstream opposite Sentinel Peak, was constructed in 1883. Although initially both lakes were built to hold irrigation water and operate flourmills, they also served a recreational purpose. Silver Lake, equipped with boat docks and stocked with carp and other fish, had a resort hotel on its banks. Of the two, the twenty- to thirty-acre Warner Lake appears to have been especially favored by migrating waterfowl and was leased to a duck club in 1885.

Both lakes took big hits during the floods of 1886, and then, in 1890:

> Sunday [July 27] the Santa Cruz overflowed its banks at Silver Lake, passing around the hotel. The overflow carried out a large number of carp, many of which Mr. Swart gathered up and found a ready market for them in this city.
>
> *Arizona Daily Star,* July 29, 1890

Subsequent floods the following month took out both dams and much of the irrigated fields, after which both reservoirs were rendered worthless.

To say that all of the reaches of Arizona's streamsides had been so negatively affected is an overstatement—both now and at the time of statehood. F. C. Willard, writing in 1912, noted that although the cottonwoods along the Santa Cruz River at San Xavier had recently been removed, the mesquite trees in the San Xavier Mesquite Bosque were "wonders of their kind" and "some reached 60 feet in height, with trunks scaling over four feet in diameter at the base." O'Connor (1939, 1969) recalled fondly the great mesquite forests present prior to World War I along the Salt River near Tempe, another prime example of these "secondary woodlands" that persisted along the Santa Cruz, Salt, and Gila rivers well into statehood.

Fuel Wood and Mine Timbers

Several authors (e.g., Dobyns 1981) have made reference to the denuding of Arizona's woodlands and riparian areas due to the use of wood for steam engines, cooking and warmth, mine timbers, and other construction materials during the 1870–1912 period. Indeed, Bahre and Hutchinson (1985) calculated that 443,000 cords of wood were removed from the Tombstone watershed during this period. Matched photos indicate that fuel woodcutting was local and transient, however (Turner et al 2003), and the effects of timber removal on forests and woodlands were relatively insignificant when compared to the effects of livestock on the grasslands.

Fire and Fire Suppression

By reducing the amount of grass cover, cattle not only increased soil erosion and raised evaporation and transpiration rates, they also reduced the amount of fuel that fed the formerly occurring natural fires. It was the removal of the cured grasses and the reduction in the incidence of fire that permitted the brush invasion of semidesert grasslands and the thickening up of the forests and woodlands that most changed the landscapes of Arizona.

Market and Plume Hunters

Wildlife Commerce in Arizona Territory

It is also difficult today to appreciate the role that market hunting—the commercial sale of game—played in the development of territorial Arizona. According to the *Weekly Alta California,* the area around Granite Creek was "good game country" and a principal reason for selecting Prescott as the first capitol of Arizona Territory. Game supplied most of the meat in mining camps and army posts, and large bags were required to feed troopers and Indian scouts. Moreover, wild game, including native fishes, provided much of the settler's fare during the early territorial years, as cattle and sheep were usually unavailable for home consumption until well into the 1870s. Even then, livestock were raised mostly for stocking purposes or for sale to the Army and other buyers. And what was available could be expensive, a range steer bringing from fifteen dollars to twenty-five dollars on the hoof according to Will Barnes (1936) and other sources.

Market Hunting

That early day Arizonans considered game to be an important commodity there can be no doubt; literally scores of entries and advertisements offering game meat appear in the territory's newspapers. Lockwood (1932) reprinted this July 4, 1864, menu for the Juniper Inn in Prescott:

Breakfast: Fried venison and chili.
Dinner: Roast venison and chili, chili baked beans, chili on tortillas, tea and coffee with milk.
Supper: Chili, from 4 o'clock on.

Game as well as hunters to procure it were much in demand. Consider this advertisement in the *Prescott Daily Miner* for November 23, 1867: "Wanted, Immediately, a Good Hunter. Apply to J. H. Lee, at the American Ranch, Round Valley. Good wages will be given."

Wages were the exception, however, as most market hunters were paid for what they brought in. Augustus Brichta (Biography of Augusta Brichta, Arizona Historical Foundation, Charles Trumbull Hayden Library, Arizona State University) sold deer to butchers in the Prescott area mining camps for $2.50 each, the venison then selling for between

> The deer season was opened with the fifteenth, hence there are many hunting parties going into the deer field of the mountains, especially in the northern sections of Arizona, where this game abounds. The Catalinas are the home of all kinds of deer and other wild animals, so we may expect plenty of venison on the markets within a short time.
>
> *Arizona Daily Star,* November 19, 1902

Finally, in 1903, market hunting was prohibited in its entirety. Of course not everyone got the word, and there were always those who were determined to continue their vocation despite the law, sometimes by bringing game meat in from Mexico. Such attempts were vigorously opposed, however, and market hunting and the sale of game meat had pretty well ceased by the time of statehood:

> Mexican Venison Reaching Arizona. Hunting season closed in Arizona, but hunters bringing deer in from Mexico for sale in Douglas markets. Fish and game warden for the territory says that the sale of such animals is illegal. Douglas attorneys o.k. it. Will check the law out in Washington [Shortened and paraphrased].
>
> *Arizona Daily Star,* January 31, 1908

The prohibition against selling game meat was retained in the State Game Code and violators were generally punished when apprehended. For all practical purposes, purchasing venison and other game was no longer tolerated:

> E. Meeks, for whom a warrant was issued several days ago by Justice O. E. Comstock, charging him with killing deer out of season, was arrested Friday and brought to the city . . . by officer Miles, a county ranger. There has been a great deal of complaint by sportsmen . . . that certain persons were killing deer out of season and selling the meat. . . . Officers say that Meeks contends that he was not killing any deer and that the meat he sold was wild hog meat.
>
> *Arizona Daily Star,* March 23, 1913

> E. Weeks, charged with selling deer meat out of season, was arraigned before Justice Comstock yesterday afternoon at 3 o'clock and found guilty, but sentence in the case was suspended, Weeks having already served nine days in jail since his arrest at

> On Thursday morning an Indian caught a Colorado River salmon weighing 85 pounds.
>
> *Arizona Sentinel*, September 29, 1883

> Thirteen pound Colorado River salmon caught on Verde
>
> *Coconino Sun*, August 16, 1894

Using handmade seines and hoop nets, the Indians not only took Colorado River salmon, they also netted bonytails and razorback suckers for their own consumption:

> Indians can be seen daily with large strings of fish, of the sucker variety.
>
> *Arizona Sentinel*, May 22, 1886

> The Indians are catching a large number of Colorado salmon in the river. Some of them weigh from 25 to 50 pounds each. When properly dressed and cooked they are very good eating. As the water becomes cooler the hardness and flavor of the fish improves.
>
> *Arizona Sentinel*, October 1, 1892

With a fish so fine as the Colorado salmon, it was only natural that sportsmen would try to catch them with hook and line—sometimes with satisfying results, the adult fish feeding on smaller fish and taking both baited hooks and artificial lures:

> Plenty of fish in the Gila River now, and they take the hook very well, several Colorado salmon having been caught that weighed 10 pounds each.
>
> *Arizona Sentinel*, June 19, 1886

> The air was balmy, no wind blew, and a universal quiet prevailed when suddenly Jack (Hillers) uttered several exclamations not entirely in harmony with the moment. He thought his precious hook was caught on a snag. Pulling gently in order not to break his line the snag lifted with it and presently he was astonished to see not the branch of a tree or a water-logged stick, but the head of an enormous fish appear above the surface. Had there been some splashing he would have been prepared for the extraordinary sight, but the monster came with barely a wiggle as if it did not know that it was about to be caught. He was successfully landed in the middle cabin, which was empty except for some

> water, and lay there unhurt as if it were the natural place for him. Casting again, another of the same kind came forth and then a third. The longest appeared to be the length of the cabin, as he floated in the water, and that was four feet. He was at least thirty or thirty-six inches with a circumference of fifteen inches. These fish are called Colorado River salmon. The flesh was white and they seemed to us good eating (Dellenbaugh 1909).

Bonytails or humpbacked chubs also supplied sport, not only along the lower Colorado, but also in the lower Gila River:

> Trout [bonytails] 20 inches long and numerous other sorts and sizes of fish are being caught in a lagoon near the [Tacna] school house.
>
> *Arizona Sentinel*, June 19, 1886

> The Gila has a bold, strong, warm stream at Antelope mountain, and the camel-back fish are searching for shady side in deep holes along the rocky banks.
>
> *Arizona Sentinel*, July 31, 1886

Arizona's fishes were without legal protection, however, and prone to abuse. Damming streams and diverting water through *aequias* or canals to irrigate fields could be especially damaging as the fish would become trapped and either be secured as human or animal food or dumped into fields as fertilizer:

> Mr. Cotton caught several hundred very fine fish in a few hours on Saturday last in the Griffin Ditch.
>
> *Salt River Herald*, May 4, 1878

Another cause of destruction was the use of dynamite or "giant powder" as a fishing technique. As was the case with fish caught in irrigation canals, far more fish were killed than were used or needed and the "catch" included all sizes:

> It is to be regretted that Arizona has no laws for the protection of fish in her rivers. Almost daily we see great loads of fish coming into Phoenix from the Salt River that have been caught by the use of giant powder.
>
> No secret is made of the fact whatever. The worst feature of the matter is that not only are fish fit for the market taken, but the fry are also destroyed and large quantities of fish considered too

A miner and his burro with two large "Colorado River salmon" taken on the Salt River near the present site of Roosevelt Lake. These fish were probably secured with the aid of "Giant Powder." PHOTO COURTESY OF W. L. MINCKLEY.

> small to trouble with are left to decay. The river has been nicely stocked with excellent fish, but is being rapidly depopulated, and a couple of years more will leave that beautiful stream without fish, if some means are not found to check this wanton and wicked destruction of its finny inhabitants. We say wicked because it is a destruction of food, unnecessary and uncalled for. The time has been when the river would furnish an excellent breakfast of fish for every table now in the valley during the entire fishing season. In short it has contained a great abundance of fish—are there no means by which this can be corrected until the next legislature meets? Have our Board of Supervisors no jurisdiction in the matter?
>
> *Phoenix Herald*, May 5, 1879

On more than one occasion, it was not only the fish that were harmed:

> Two sons of F. M. Fowler of this city, met with a very serious accident last Thursday, while fishing in the Verde above Fort McDowell. They were using giant powder when one of the cartridges exploded which so injured Lincoln as to render amputation of the wrist. Frank is not so badly hurt.
>
> *Phoenix Herald*, July 19, 1879

A man whose name we did not learn, while out fishing last evening in Salt River, using Giant Cartridges, held the instrument of destruction in his hand too long, which exploded, so mutilating the member as to cause amputation necessary.

Phoenix Herald, July 21, 1880

The Clifton Clarion of June 11 says: Justice Sine sentenced a culprit $15 and costs for killing fish with giant powder, and added that he would next time affix the full penalty of the law.

Phoenix Herald, June 14, 1884

The use of seines or hand nets could also be destructive to fish:

DESTRUCTION OF FISH

There are several parties who are seining the irrigation canals for fish, with good success, catching large quantities. There is a bad feature of this method of fishing; large and small are caught and instead of throwing the small ones back into the water they are left on the ground to die, thus destroying the future product. ... It is easy to see that waste is being done. Some measure ought to be adopted to stop it.

Arizona Daily Star, January 28, 1887

In 1881, in an attempt to halt these abuses, the territorial legislature had banned the use of dynamite and seines for taking fish on all but private property—the first laws to protect wildlife in Arizona Territory (Appendix C). But other activities harming Arizona's fishes were not so easy to regulate, especially the careless discharge of sediments and other pollutants into streams, thus destroying any and all fish downstream:

SAN PEDRO LETTER

On the 10th the rains began to fall and the next day the rivers were rushing down spreading the water all over the various ranches. The only drawback was the killing of all the fish in the lower San Pedro and Gila, caused from the tailings of the Mammoth mill. They died by the ten thousand and it will take years to replace the loss.

Arizona Weekly Star, August 19, 1886

Commercial fishing could also result in some large catches, a practice that may have been detrimental in some of the smaller streams:

Fishing for Speckled Mountain Beauties

Arizona's Native Trouts

They say that fishermen are made not born. This certainly appears to have been the case with trout fishermen in Arizona Territory. Native peoples, such as the Apache and Yavapai, who inhabited Arizona's higher elevations, reportedly had a cultural aversion to fish and fishing. The same could be said for most early Arizona settlers who were so busy trying to feed their families that they had little time to try their hand at recreational fishing. That Arizona possessed an abundance of native trout, then variously known as "speckled trout," "mountain trout" (to differentiate them from "Verde trout" or chubs), and "yellow trout" or "yellow-bellies"[5] was nonetheless well known, and trout fishing was touted as an inducement for out-of-state tourists accustomed to such sport:

> The main upper branches of the Salt River, the White and Black rivers, are both swift running streams, and rise in the White Mountains. They are well stocked with the real speckled mountain trout, affording rare sport to the followers and devotees of Isaak Walton.
>
> *Salt River Herald*, January 26, 1878

> In the streams which form the head waters of the Colorado Chiquito, as well as those of the Salt and the Gila, trout are found in abundance. In the cool and sparkling streams which flow down from the winter snows of the Mogollon and Sierra Blanca and the San Francisco, these beautiful fish find a permanent home. They are equal in flavor to the best Eastern or California brook trout, and magnificent specimens, weighing as high as four and five pounds, are not unfrequently taken (Hinton 1878).

Such pronouncements did not fall on deaf ears. No sooner was the railroad completed across Arizona's "high country" between Albuquerque and Flagstaff then tourists bearing fly rods began arriving to "test the waters," so to speak. One of the earliest of these sportsmen

[5]None of the early references refer to these trout as "Arizona trout," "Apache trout," or "Gila trout," names which were applied much later.

accomplished almost entirely through private donations and the efforts of volunteers. That the department had managed to acquire ring-neck pheasants and trap Gambel's quail to stock was due only to a special $500 appropriation by the legislature.

Statehood saw a very different Arizona than the one that the settlers had found nearly fifty years earlier. The census of 1910 showed a population of 204,354 people and 934,000 cattle in fourteen counties. Most of the state's important towns were now in place, each connected by railroads and/or highways, none of which were yet paved. Huge irrigation projects had been initiated to use the waters of the Colorado and Salt rivers, and most of the Indians had been "provided" with reservations; only the lands claimed by the Papago, or O'odham, remained to be apportioned. Similarly, the national forests were now essentially in place, and nearly ten million acres of "school sections" had been given to the State of Arizona under the Enabling Act. Except for the national parks, monuments, and wildlife reserves that were designated later, Arizona's land status in 1912 was not too different from today's.

Changes to the natural as well as the cultural environment had taken place, many of them severe. After twenty years of drought and grazing by nearly a million cattle, Arizona's grasslands were not only in need of a rest, encroaching shrubbery and the loss of fine fuels meant that most of them would never again attain their former grandeur. The growing practice of fire suppression was resulting in denser chaparral and thicker, more fire-prone forests. But perhaps the most affected habitats were the streamsides. The frequent flooding of eroded river channels would eventually result in demands to dam, channelize, and harness streams large and small.

Game conditions were especially grim, with meadow, grassland, and savanna species suffering most. Three native wildlife species—elk, bobwhite, and aplomado falcon had been extirpated during the territorial period. Riparian animals had also fared badly, with beavers and otters now nearly extinct, and native fishes being replaced by introduced species. Predators, prairie dogs, and jackrabbits were being poisoned, clubbed, shot, and otherwise killed off as quickly as possible.

Pronghorn, nearly eliminated from much of southern Arizona, were thought to be gone north of the Grand Canyon and much reduced elsewhere. By all accounts, mule deer, too, had diminished in numbers, the various national forests in Arizona reporting a total annual kill