

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND GAME

GAME BULLETIN No. 3

The Status of Beavers in California

BY
DONALD T. TAPPE



1942



H1312/1543
23/1/69

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND GAME

GAME BULLETIN No. 3

The Status of Beavers in California

BY
DONALD T. TAPPE

Museum of Vertebrate Zoology and Division of Fish and Game
in cooperation with
Federal Aid in Wildlife Restoration Project, California 2-R



1942

TABLE OF CONTENTS

| | Page |
|---|------|
| INTRODUCTION | 5 |
| HISTORY OF BEAVERS IN CALIFORNIA..... | 7 |
| ENACTED LEGISLATION CONCERNING THE BEAVERS OF CALIFORNIA... | 11 |
| LOCATION AND DESCRIPTION OF COLONIES..... | 13 |
| Beaver Colonies of Northern California and the Sierra Nevada..... | 16 |
| Beaver Colonies of the Great Valley of California..... | 20 |
| Beaver Colonies of Southeastern California..... | 23 |
| PRESENT ECONOMIC STATUS OF THE BEAVERS OF CALIFORNIA..... | 30 |
| HABITAT REQUIREMENTS | 35 |
| THE PLANTED BEAVER COLONIES IN CALIFORNIA..... | 41 |
| FUTURE OF BEAVERS IN CALIFORNIA..... | 54 |
| RECOMMENDATIONS | 55 |
| LITERATURE CITED | 58 |

The Status of Beavers in California

By DONALD T. TAPPE

INTRODUCTION

The beaver is the largest of all the several hundred kinds of rodents in North America (fig. 1). It is one of the most valuable fur-bearing mammals, and aside from man it is the only animal capable of materially altering its environment to suit its needs. Many persons are surprised when told that beavers live in California for, in the mind of the average person, beavers are associated with the colder climate of the North where the importance



FIG. 1. Young golden beaver captured 4 miles west and 1 mile south of Snelling, Merced County. Weight 21 pounds. September 22, 1941. (All photographs are by the author.)

of the animal's pelt to the early settlers is well known. Nevertheless, beavers once were common on most of the streams of the Great Valley, and in the southeastern and northern parts of California. They still live in these parts of the State, although their numbers are greatly reduced. There probably are no more than 1,300 animals in California today.

Much of the early exploration of California was done by traders and trappers in their search for new areas in which to take beavers. The intensive and continued trapping by these men soon led to a great decrease in the beaver population. Although there was relatively little trapping done in the last half of the nineteenth century, the beaver population remained at a comparatively low level; the population even became so reduced that the animal for a time was threatened with extinction.

It is now understood that soil erosion and shortage of water in some places resulted from the destruction of the beavers which formerly built, and kept in repair, dams on the upper reaches of many streams. The dams were the effective means of impounding waters of the spring runoff, and of distributing them slowly downstream throughout the Summer. Recognition of this important relation of these animals to man, and recognition also of other values inherent in the beavers themselves, led to attempts in many of the Western States to reestablish them in places where they had become extinct.

In 1934 attention was focused on parts of California with this objective in view. California was fortunate in that a nucleus of each of the three kinds of beavers which originally occurred in the State still was found here. These are: *Castor canadensis shastensis* Taylor (Shasta beaver), *Castor canadensis subarcticus* Taylor (golden beaver), *Castor canadensis repentinus* Goldman (Sonora beaver).

It seemed to many persons that through wise protection and encouragement the animals could be reestablished with relative ease. The reestablishment of beavers was not as easy a task as some persons supposed. For one thing, although the benefits which beavers confer are well known, their presence sometimes is also a nuisance locally, as for example in the lowlands where a limited amount of water is available and beavers and man have diametrically opposed ideas as to the direction in which the water should be diverted.

It was with the aim of better understanding the beaver's role in the modern fauna of California that the study now reported upon was undertaken. Five main objectives were settled upon, as follows:

- (1) Ascertain the number of each of the three kinds of beavers in California.
- (2) Learn the location of existing beaver-colonies.
- (3) Learn the habitat requirements of beavers in California, giving attention to whether or not there are differences in this regard between the three kinds.
- (4) Record as much as could be learned of the history of colonies of beavers transplanted within, or into, California.
- (5) Indicate the economic status, and record such other information as will probably be useful to governmental agencies, and conceivably even to private individuals, who may develop a plan of management for the beavers as a part of our effort to make the wisest possible use of this natural resource.

The opportunity to realize these objectives was afforded on February 15, 1940, when the writer was appointed Research Assistant on the staff of the Museum of Vertebrate Zoology of the University of California at Berkeley under the Wilhelm L. F. Martens Wildlife Conservation Fund. Mr. Martens in 1934 bequeathed to the University a permanent fund, the income from which, through the Museum of Vertebrate Zoology, was to be applied in bringing about better protection of the native vertebrate fauna of California by the people and the government. This purpose of conserving and protecting wildlife seemed particularly well served by bringing together a factual statement of the history of the California beaver. In this undertaking, the California Division of Fish and Game, Department of Natural Resources, lent its full cooperation. With certain funds made available through the Pittman-Robertson Federal Aid in Wildlife Restoration Act, the Division of Fish and Game was able to meet the travel expenses and some other field expenses of the investigation. It will be seen, therefore, that credit for whatever merit there may be in the present report belongs to several organizations. The Regional Office of the United States Forest Service generously made available its files on the transplanting of beavers in the National Forests. I wish to acknowledge my indebtedness to Dr. E. Raymond Hall, of the Museum of Vertebrate Zoology, for numerous suggestions and critical assistance in the preparation of the manuscript. At the same institution, other staff members, particularly Drs. Alden H. Miller and Seth B. Benson, were helpful, and I owe a very large debt of gratitude to Mr. J. S. Hunter and Mr. Gordon H. True, Jr., of the California Division of Fish and Game; to Messrs. Robert Hart, Arthur L. Hensley, Leo Rossier, and George D. Seymour of the same Division; and to Joseph S. Dixon of the National Park Service. To single out names of friends who have in many other ways aided, especially in the field work, would be invidious. Although the names of some of these appear in the text beyond, the majority are recorded only in the author's grateful remembrance of their generous assistance.¹

HISTORY OF BEAVERS IN CALIFORNIA

In the early part of the nineteenth century the range of the Shasta and golden beavers in California was considerably more extensive than it is today; on the contrary, the range of the Sonora beaver then was less extensive than now (see fig. 2). This is explained by the fact that the recent construction of canals has provided habitats for beavers in the Imperial Valley where none formerly was present.

In northern California there were beavers, probably of the race *shastensis*, on the Pit, McCloud, Klamath, Shasta, Scott and Trinity rivers and their drainages. In the Great Valley, golden beavers lived at least as far south as the Kings River, and probably as far south as the Kern River. It is reported that trappers working for the Hudson's Bay Company took furs as far south as Buena Vista Lake in Kern County, but that they usually considered it unprofitable to work farther south than the shores of Tulare Lake. Since the main item trapped

¹ Manuscript typed by personnel of Work Projects Administration Official Project 2165-1-68-73, Unit C-1.

was beaver, it seems probable that what trapping they did do south of Tulare Lake was for beaver. Beavers were apparently not uncommon on the upper part of the Kings River as late as 1880. Mr. Andrew D. Ferguson, a retired game warden now (1940) living in Fresno, reports that the last fresh beaver cuttings seen by him on this stream were noted in 1882-83. According to him, beavers were scattered all along the Kings River prior to this, but were most abundant along that part

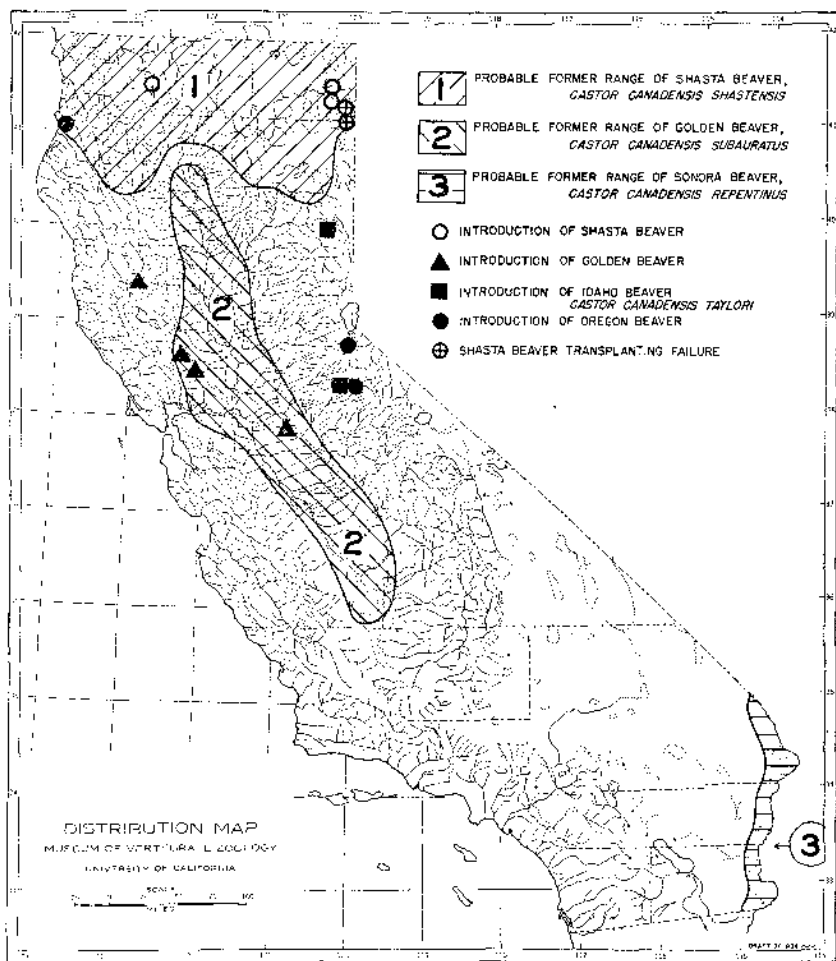


FIG. 2. Probable former range of beavers in California, with location of sites where beavers have been transplanted by governmental agencies in recent years.

of the stream near the present town of Centerville. From a reading of the journals and accounts left by early trappers, it appears that beavers were common on the San Joaquin River and its tributaries north of the Kings River, and on the Sacramento River and its tributaries almost as far north as the present town of Redding. However, as far as could be learned, these animals confined themselves to the parts of these streams below the 1,000-foot level. Beavers were especially numerous in the

delta area, where the Sacramento and San Joaquin rivers join and enter Suisun Bay. In southern California Sonora beavers were found only on the Colorado River, which forms the State's southeastern boundary.

The beaver had a part in the development of the State of California similar to that played by this animal in other parts of North America. Although the role played by this rodent in the interior of California was probably not as great as elsewhere on the continent, it was nevertheless important in attracting explorers and adventurers into this area. The quest for beaver pelts prompted several fur companies to send parties into California, the ultimate result of which was a wider knowledge of the land and its resources, later utilized by the permanent settlers who began to establish themselves in considerable numbers after depletion of fur-bearing mammals made the areas unattractive to those whose aim was to trap on a large scale.

One of the first men to enter California in quest of beaver pelts was James Ohio Pattie, who, with a party of seven others, trapped this animal on the Colorado River in 1827. An indication of the abundance of beavers on this stream at that time is given by Pattie's statement that 36 beavers were taken in 40 traps in one night near where the Helay (Gila) River enters the Colorado. About 40 miles farther down stream, apparently near the mouth of the Colorado in what is now Mexico, the trappers in this group took as many as 60 beavers in one night (Pattie, 1930, pp. 226-228). In this trip down river they took more than eight canoe-loads of beaver pelts, which they buried in the ground for safekeeping while they traveled overland to the coastal Spanish settlements to re-equip themselves with horses and essential supplies. Before they could return, a rise in the river flooded their cache and spoiled the furs. Ever since Pattie made his trapping expedition in 1827, the Colorado has been known as a famous beaver stream. It has been intensively trapped several times since, but enough beavers always were left to furnish breeding stock for its repopulation.

In 1828 Jedediah Smith made a journey up the Great Valley of California to a point near where Red Bluff now stands. From there he journeyed across the Coast Range and down the Trinity and Klamath rivers to the coast, whence he journeyed north to Fort Vancouver in Washington. Smith reports beavers as being on the American River and on the lower Feather River, where his men on the night of March 11 took twenty in 28 traps (Sullivan, 1934, p. 69). He also trapped beavers with fair success on the Feather River as far up as the Sutter Buttes, and on Butte Creek. Smith further mentions (*loc. cit.*, p. 74) that beavers were scarce on the Sacramento River near the mouth of Butte Creek because its banks were too sandy for them to live in, but that a short distance back from the stream there were beavers in lakes and ponds. He states also that beavers were plentiful on the Sacramento River near its confluence with streams now named Stony Creek and Deer Creek, and that they were on Toomes Creek. In his trip across the Coast Range, Smith found beaver sign near what apparently was the mouth of the Klamath River, and purchased skins from Indians in that vicinity (*loc. cit.*, p. 96). Smith makes no mention of seeing beaver sign on the Trinity River, but Harrison G. Rogers, who accompanied Smith, in his second journal reports sign on what I judge was either the Trinity River or the South Fork of the

Trinity River in the vicinity of the present Burnt Ranch, in Trinity County. Rogers also notes that Indians living along the Trinity River near its confluence with the Klamath River possessed beaver and otter skins (Dale, 1918, pp. 238, 247).

Another record of beavers in the Sacramento Valley is that of Wilkes (1844, p. 261). When he and his party arrived at the "Little fork of the Butes Creek" near Prairie Butes (Sutter Buttes) in 1841, hunters there told him that in the previous year a party of Hudson's Bay Company men took more than a hundred beavers in that locality. Another trapper, Tom McKay, obtained beavers on the Scott, Pit, McLeod (McCloud), Shasta, Feather and American rivers.

According to the journal of Peter Skene Ogden, the upper Klamath and Shasta rivers apparently were inhabited by beavers. Ogden trapped them on the Sastise (Shasta) River with good success. Also, an advance party of nine men from Ogden's main company went down what apparently was the Klamath River almost to the coast, and returned with a total of 107 beaver and nine otter pelts (Elliot, 1910, pp. 214-215). How far down river beavers occurred is not stated. C. W. Holmes, who owns a ranch along the Scott River near Fort Jones, told the writer that beavers were present in that area as late as 1929 or 1930, and that the last colony of native beavers on the Scott River known to him was located about $2\frac{1}{2}$ miles southwest of Fort Jones on Marlahan Slough. This colony was trapped out in the winter of 1929-1930 by a local trapper. Frank C. Jordan of Fort Jones states that beavers were scarce on the Scott River in 1896, when he trapped only eight and felt that he had done well, considering the scarcity of the animals. According to Jordan, a friend of his, Mr. Joseph Meek, told him that he trapped in the Scott Valley with a large party of trappers around 1850. Meek said that this party in one year took about 1,800 beavers along Scott River and Marlahan Slough. After the party left, Mr. Meek remained in Scott Valley and established residence. He trapped independently for a number of years, but without good success in catching beavers. Several other residents of Fort Jones, who knew Mr. Meek, corroborated Mr. Jordan's statement about the story handed down by him. The writer talked to several people who were acquainted with Mr. Meek and all said that his word could be relied upon.

The beaver was one of the most important of the fur-bearing mammals sought by the early traders who came by sea to the coast of California. As early as the first of the nineteenth century fur traders working along the coast of California traded for the pelts of beavers, although the traffic in pelts of sea otters was then much more important. Bryant (1915, p. 99) reports that in 1810-11 a vessel engaged in the fur trade took from the coast 248 beavers, along with a large amount of sea otter and other fur.

The first and most important of the fur companies operating in the interior of California was the Hudson's Bay Company. It first sent an overland "fur-brigade," as the trapping expeditions were called, into California from Fort Vancouver in 1828 under the leadership of Peter Skene Ogden. This brigade trapped in the Great Valley of California for eight months in the winter of 1828-29, and returned with a large collection of furs. Every year from this time until 1845 the Hudson's Bay Company sent into California fur-brigades number-

ing up to 200 men each. Men in these expeditions trapped and hunted other mammals, as well as beavers. After reaching California the fur-brigades split up into smaller units, each working in a particular part of the interior valley. Their operations extended as far south as southern Kern County, although most of their trapping was carried on north of Tulare Lake. Most of the beavers apparently were taken on the Sacramento and San Joaquin rivers and their tributaries, and in the delta where these two main streams merge before flowing through Carquinez Straits into San Francisco Bay, although some were taken in northern and northeastern California. One of the main trapping headquarters of the Hudson's Bay Company was French Camp, near Stockton, where their ships called.

Besides the Hudson's Bay Company, several American fur companies trapped beavers in California at about the same time, but for the most part these were unable to compete successfully with the larger British company. Nevertheless, in 1839 General Sutter established himself on the Sacramento River and successfully competed for the purchase of furs. After that the power of the Hudson's Bay Company began to wane. Sutter succeeded in persuading the Government to levy and collect an export duty on beaver skins, making the operations of the Hudson's Bay Company, which exported most of its skins, less profitable. This act of Sutter's, together with the fact that beavers were becoming scarce, offers an explanation for the company's abandonment of its trapping operations in California in 1845-46.

Trapping of beavers in the delta area was more difficult than elsewhere; the tides and nature of the ground interfered with the trappers' work. In commenting on the habits of the beavers in the delta and on the methods of securing the animals, Duflot de Mofras states that the beavers usually made their homes in holes dug along waterways or lagoons. When floods occurred, they withdrew to dry localities, where new dwellings were erected. As the traps and skins were heavy, each trapper invariably was accompanied by an Indian or a horse to transport his equipment. Frequently hunters hid and shot the beavers, without setting traps (Duflot de Mofras, 1844, pp. 460-461).

The beaver-fur traffic was a business that paid fairly well during the first half of the nineteenth century. George Nidever (1937, p. 34) and a companion trapped and hunted around San Francisco Bay and on the San Joaquin River for two months in the Winter of 1834-1835, and took about 30 beavers, 14 land otters, and 2 sea otters. Beaver skins then were worth about \$4 each, land (river) otter skins about \$2, and sea otter skins about \$30 each. Another report states that in 1830 Jean-Baptiste Desportes Mackay, a well-known trapper of the Hudson's Bay Company, caught within six months near Carquinez Bay more than 4,000 beavers. Probably he had several assistants. At this time the skins sold for two piasters a pound in California and one pound sterling in New York and London (Duflot de Mofras, 1844, pp. 461-462).

ENACTED LEGISLATION CONCERNING BEAVERS

Despite the fact that its specialized habits make the beaver more subject to extermination than most mammals when heavily trapped, no special effort was made to protect it in California prior to 1911. Indiscriminate trapping had caused such a decrease in the beaver popula-

tion that its extermination was threatened at this time. Having been made aware of this danger, the State Legislature in 1911 enacted a law providing for the complete protection of this mammal.

A rapid increase in the beaver population followed, especially in the delta area. The animals became so common, in fact, that ranchers in the delta were fearful of the damage that the beavers might do to the levees holding water back from their reclaimed lands. Consequently, in 1917 the law protecting beavers was amended to allow for the trapping of them by any person when these animals were endangering or destroying the levees or other protective works of any reclamation, levee or swamp-land district, provided a request was made in writing to, and a written permit obtained from, the Fish and Game Commission. The law provided that any one taking beavers under a permit was to report the act in writing to the Commission, whereupon the Commission might issue a written permit for the disposal of the pelts. Anyone violating this law was subject to a fine of not less than \$25, nor more than \$500, or imprisonment in a county jail for not less than 25 days, nor more than 150 days, or by both such fine and imprisonment.

In 1925, as a result of further pressure from land owners in the delta, this law was again amended to allow the taking of beavers, and the possession of green beaver hides, in Fish and Game Districts one, two and three. Since beavers had not been included on the list of furbearing mammals defined in 1917, and no provision was made in 1925 to place them there, technically the law made it permissible to take beavers at any time of the year in these three districts. In 1927 this defect in the law was remedied by placing beavers on the list of furbearing mammals.

The wholesale trapping of beavers that followed the opening of the season on them in 1925 led to a sharp decrease in their numbers. Their extinction was again threatened, not only in districts one, two and three, but also on the Colorado River where trapping of this mammal was still unlawful. A number of persons who lived along the Colorado River from 1925 to 1933 have told me that many beavers were trapped there in those years, apparently because it was the general opinion that the open season applied to beavers everywhere in the State, rather than to any specific locality. A similar situation applied in northeastern California.

The decline in the population of beavers again led to the placing of this animal on the protected list in 1933. Provision was made, however, to allow for the issuance, by the Fish and Game Commission, of a regulated, revocable permit for the taking of beavers where satisfactory evidence of damage or destruction, actual or threatened, was presented. Beavers so taken were not to be sold or shipped from the premises where taken, without special permission from the Commission.

The protection that beavers enjoyed after 1933 allowed them to increase in numbers and once more their activities become a matter of concern to the owners of delta lands. Accordingly, in 1939 there was added to the existing beaver laws a provision requiring that the Fish and Game Commission establish a beaver-control area in places where it could be demonstrated that beavers were damaging or threatening to damage or destroy lands, crops, levees or other irrigation structures.

The Commission was required to define the boundaries of such areas and permit the taking of beavers under rules and regulations of the Commission, which would permit the marketing of the pelts and the immediate correction of damage until such time as the damage or threatened damage was abated.

LOCATION AND DESCRIPTION OF COLONIES

There are three areas in California where native beavers are found. These are (1) northeastern California where the Shasta beaver *Castor canadensis shastensis* occurs, (2) the San Joaquin and Sacramento valleys where the golden beaver, *Castor canadensis subauratus*, is found, and (3) the Colorado River and the Imperial Valley in southeastern California where the Sonora beaver, *Castor canadensis ripentinus*, ranges (See fig. 3). There are no known records of beavers ever having occurred in the Sierra Nevada, except where these mam-

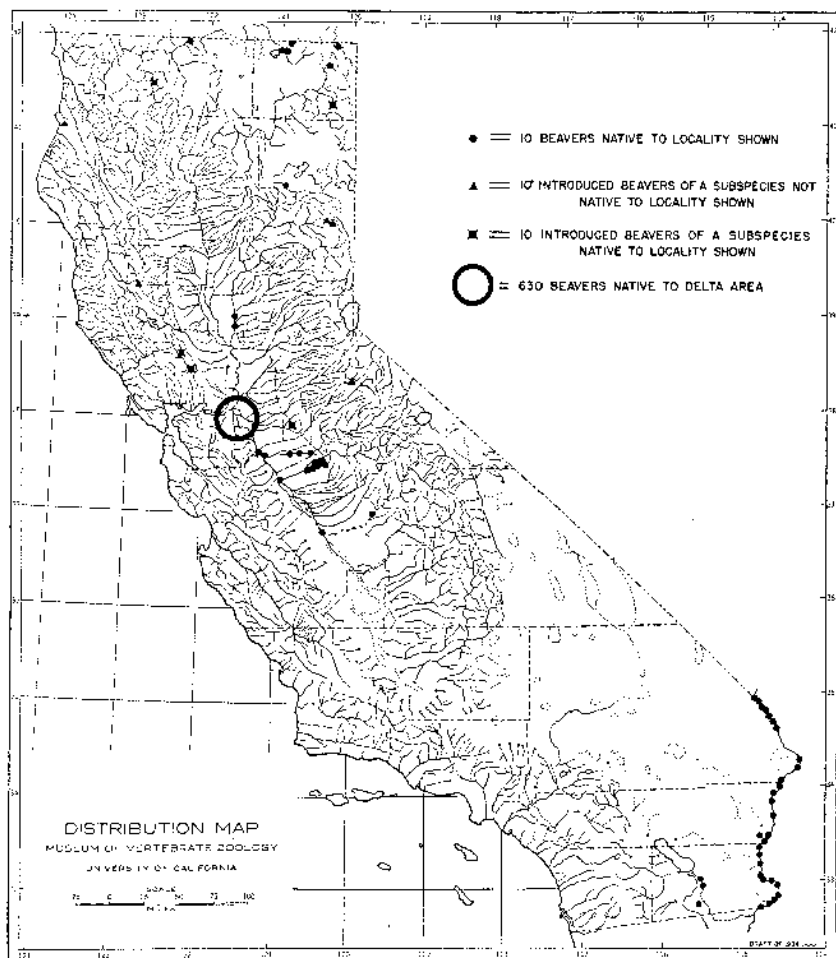


FIG. 3. General distribution of all beavers in California.

imals have been recently introduced there by man.² There is one questionable record of beavers occurring near the coast of southern California along the Sespe River in Ventura County. This record, a single skull of an adult male said to have been taken in May, 1906, formerly was in the collection of Dr. John Hornung and now is in the California Museum of Vertebrate Zoology. Because of the arid nature of the country it seems improbable that beavers ever occurred extensively in this area within historic time at least. There are no known records of native beavers from the coast of northern California south of the Klamath River, although they probably occurred in at least the northern part of this area. Because of the relatively heavy rainfall there, this area seems more suited to them climatically than does



Fig. 4. Site of native Shasta beaver colony on the Klamath River near Copco, Siskiyou County. November 10, 1940.

the coast of southern California. However, the stream beds are for the most part rocky and steep with but little beaver food growing along them, conditions which limit their suitability for this mammal.

All of the areas known or thought to contain colonies of beavers were visited by the author in the course of this study. The locations of the colonies were recorded, and an attempt was made to estimate the number of animals living in each. This estimate usually was

²Since the above account was written, the writer, through the courtesy of Mr. G. H. Hansen of the Fish and Wildlife Service, Reno, Nevada, on October 1, 1941, interviewed Mr. Roy Michels, who was born in Carson City, Nevada, in 1872 and now lives in Reno. Mr. Michels spent much of his time between the ages of 14 and 20 riding the range in Alpine County, California, and in Ormsby and Douglas counties, Nevada. He said that in these years (1886-1892) beaver cuttings were plentiful on the upper part of the Carson River and its tributaries in Alpine County. He attributes the disappearance of beavers from the Carson River drainage to the heavy trapping done in that area prior to 1900. It seems, therefore, that beavers actually did inhabit at least a part of the eastern slope of the Sierra Nevada south of Lassen County.

based on a combination of two or more of the following factors: (a) amount of vegetation freshly cut by beavers, (b) size and number of fresh tracks left by the animals, (c) size of tooth marks, (d) number of fresh slides present, (e) number and size of dams, canals or inhabited houses, and (f) actual count of the live animals. Where tooth marks on cut vegetation in the same spot clearly showed that work had been done by both adult and juvenile animals, it was assumed that a mother and a litter of three young were present in a colony. Thus, the population of such an area would be estimated as four beavers, the same interpretation was applied to tracks where those of adults and juveniles were found together. Where many fresh cuttings and other signs were scattered uniformly along a large stream for



FIG. 5. Willows cut by beavers along Klamath River near Copco. Note rocky nature of ground-surface. November 10, 1940.

several miles, as was the case in places along the Colorado River, such sections of streams were arbitrarily assigned an average population of not more than five animals per mile of bank that formed a favorable beaver habitat. This procedure was not applicable in the delta area, because the numerous islands, locally termed "berms," left after dredging and diking the canals, provided a greatly increased supply of available dwelling sites and food. Accordingly, allowance was made for a relatively higher average population of beavers per mile of waterway than in most other areas.

It should be understood that the number of animals given as inhabiting each area is merely an estimate based on the evidence the writer was able to gather in a survey of this kind. An effort was made in every instance to be conservative in making the estimate.

Beaver Colonies of Northern California and the Sierra Nevada

The Shasta beaver, once relatively common in many of the streams of northern California, now is found only in scattered places within its former range. Most of the present colonies are remnants of what was once a flourishing native population. The other colonies are the results of efforts at transplanting on the part of State and Federal conservation agencies. Unfortunately not every transplantation has been made with stock native to the area where it was introduced.

On Little River between points $\frac{1}{2}$ mile below and 8 miles above Crannell in Humboldt County, there are five non-native beavers. This colony was planted in 1939, and is the only place in northern California where foreign beavers have been introduced into an area thought to have been formerly inhabited by a native species.⁸

In the summer of 1940, 9 golden beavers were released on Rice Creek, near where this stream enters Lake Pillsbury, in Lake County. One small animal was found dead at the place where the animals were released a few weeks after the plant was made, so that there must have been no more than 8 animals present there in the autumn of 1940.

In Scott Valley, Siskiyou County, 4 Shasta beavers introduced by the Division of Fish and Game in 1936 had increased until in the autumn of 1940 there were about 13 animals living in three colonies near the place of release on Marlahan Slough, about 4 miles south and one mile west of Fort Jones. On August 30, 1940, three additional animals from Modoc County were added to the uppermost of the three colonies, making a total population of 16 beavers in the three colonies.

A native colony of 4 beavers was found on the Klamath River between Copco number one and number two stations of the California-Oregon Power Company, about 13 miles east-northeast of Hornbrook in Siskiyou County. These beavers were living along a rocky, but relatively quiet section of the stream, which was of a smaller size than elsewhere because of the diversion of a part of the flow to generate electrical energy (fig. 4). Some of the beaver cuttings, all of which were on willows ranging in size from small twigs up to trunks of trees 9 inches in diameter, were well weathered and appeared to be several years old. Several willows growing among small boulders had been cut (fig. 5). Beavers had recently been present also on Jenny Creek, which flows from Oregon into the Klamath River near Copco, just below the Oregon boundary, according to the employees of the California-Oregon Power Company stationed there. Probably the beavers on the Klamath River and on Jenny Creek migrated southward from Oregon where they still persist. According to Arthur L. Hensley of the Division of Fish and Game there is also a colony of 3 animals in an old, water-filled gravel pit adjacent to Willow Creek, about $1\frac{1}{2}$ miles south of Gazelle in Siskiyou County. So far as is known, these are the only non-planted colonies of native beavers in northern California west of Modoc County.

Assuming that 10 beavers in Lassen County are of the race *shastensis*, there are in all about 96 Shasta beavers now living in northern California. Of these, 63 are in Modoc County, the northeastern county of the State. This area, probably because of its general inaccessibility, and because it is sparsely inhabited by man, has served as a stronghold for this subspecies. True, the number that survived the recent period of heavy trapping has not been great, but nevertheless enough remained to perpetuate the race.

The largest group of native beaver colonies in northern California was found on the North Fork of Willow Creek. This creek flows in a southwesterly direction from Yocum Valley in Oregon into Clear Lake Reservoir in Modoc County, California. In general, the course of the North Fork of Willow Creek is through rough, rocky lava country that supports a growth of mixed juniper and sage. Scattered clumps of willow grow all along the stream, and near its mouth there are a few small beds of tules. The stream itself is of small size, and between the upper part of Weed Valley and the lower part of Hidden Valley, in September of 1940, no flowing water was in evidence on the surface. Below Hidden Valley, the flow gradually increased until near the mouth there was about one second-foot of water.

The uppermost of the 7 colonies on the North Fork of Willow Creek extended from Oregon for a half-mile into California. Ten dams, numerous fresh slides, and fresh cuttings on willows, indicated that 6 animals lived inside California. Here, willows grew in a continuous belt. About a half-mile below the lower limit of this colony, in the upper end of Weed Valley, there was a series of three new dams,

⁸For a more detailed description of the planted beaver colonies the reader is referred to the section entitled "The planted beaver colonies in California."

along with slides and fresh cuttings, made by 2 additional beavers. Immediately below this colony the growth of willow gives way to the open, meadowlike grassland in Weed Valley. Erosion was beginning within the willow-covered area where the lower colony was located, and in the open area below (fig. 6). Possibly the new beaver dams will alleviate this condition.

A third colony with 2 beavers was found on the North Fork of Willow Creek about three-quarters of a mile below Wilcox Springs, and a fourth on this same stream about 4 miles above the mouth of Boles Creek. There, sign of 3 animals was found among scattered willow clumps in the creek bottom. About three-quarters of a mile above Boles Creek there was a fifth colony, probably of 5 animals. These beavers had built no dams. Numerous natural pools were sufficiently deep to cover the entrances leading into the animals' burrows made in the banks of the stream.

About three-quarters of a mile below the mouth of Boles Creek, George D. Seymour of the Division of Fish and Game located a colony of 4 animals. There the beavers were feeding on willows and tules, and had built three dams across the



FIG. 6. Willow thicket on North Fork of Willow Creek in Modoc County, where a colony of native Shasta beavers has recently become established. Note the erosion below the thicket. September 8, 1940.

creek. The lowermost colony on Willow Creek, estimated at 3 animals, was about two miles below the mouth of Boles Creek. A dam built by the beavers was 50 feet wide and backed up the water for 200 feet, forming a deep pool. Old cuttings were scattered along the creek below this colony as far down as Clear Lake Reservoir, but there was no indication of recent activity along that part of the stream.

A colony with an estimated 5 beavers was found on the upper end of Steele Swamp, which is merely a wet meadow one mile long in the Willow Creek drainage about 35 miles northwest of Alturas, in Modoc County. These beavers had built a dam 85 feet long and 18 inches high across the creek flowing into the meadow. According to Jerry Stratton, foreman of the Steele Swamp Ranch, these beavers last year (1939) lived among a group of willow thickets in the lower ends of the meadow. Because their dams interfered with the irrigation of the meadow, Stratton disturbed the colony whereupon it moved into the willow thicket at the upper end of the meadow. The beavers in this colony were feeding on willows and on tules which grew around the dam and along the stream for the full length of the meadow. No indication was found that other colonies of beavers were living in the meadow on September 9, 1940.

A colony of 5 animals was located on Pine Creek (in California), on the ranch belonging to Mrs. Anna Schroeder, two miles east and one mile south of New Pine Creek, Oregon. According to the owner, beavers first appeared in this area in 1931, when they established themselves in a colony one-half mile below her ranch. In 1932 the colony moved upstream onto the ranch, where it has remained. Although Mrs. Schroeder has lived on Pine Creek since 1908, she saw no beaver sign there prior to 1931. Many aspens of all ages, and willows and cottonwoods grow along the creek in the small meadow where the colony is situated. The beavers have built four substantial dams, the largest of which was more than 100 feet long and $4\frac{1}{2}$ feet high. Aspens, willows and cottonwoods growing along the edges of the ponds behind the dams were being progressively cut, upstream, from each dam by the beavers and utilized for food and dam-construction.

On the lower part of Lassen Creek, 8 miles north and 3 miles east of the town of Davis Creek, there was, in the Summer of 1940, a colony of 5 beavers. A dense growth of willow, in which was mixed a small amount of aspen and cottonwood, bordered Lassen Creek where the colony was located. Beavers there had cut a large number of the willow trees for food and for the construction of a large dam at the site of the colony. In August of 1940, 2 animals were taken in live-traps and removed from this colony by the Division of Fish and Game, so that probably only 3 remained. A second colony on Lassen Creek was in a meadow 9 miles north and $2\frac{1}{2}$ miles east of Davis Creek. The 4 beavers in this colony had cut more than 240 aspens, as well as a large number of willows growing in the lower part of the meadow. A dam 65 feet long and 5 feet high, built by beavers in the lower end of the meadow, backed up the water for 200 yards in the stream bed and caused it to overflow onto the meadow for a distance of 125 yards above the dam. Two beaver houses were among the scattered willow thickets in the flooded part of the meadow. A third colony, probably of 3, was situated on Lassen Creek about $2\frac{1}{2}$ miles below this colony prior to the latter part of August of 1940. At that time two animals were taken from this colony by the Division of Fish and Game and planted on the headwaters of Shields Creek.

Two or more beavers were reported by Hensley as living on Bidwell Creek above Fort Bidwell. Willows were the most important food source of these beavers although some aspens also were present. He reported finding also a colony of five animals on the Pit River, about 40 miles southwest of Canby in Stone Coal Valley, Modoc County.

Five animals had built two dams on Parker Creek, one-half mile above its mouth, where a heavy growth of willows bordered each bank of the small stream. The willows and aspens, which were concentrated in a grove below the lower dam, had been cut for food. Scattered beaver cuttings were found also along the Pit River at the mouth of Parker Creek, but these appeared to have been made by animals living in the colony on Parker Creek.

A colony of 4 beavers planted in Pine Creek Basin on the west slope of the Warner Mountains, 7 miles west and 4 miles north of Eagleville, in 1936, was estimated to contain the original number of 4 animals in the summer of 1940. Six dams had been built. The largest was 100 feet long and four feet high. There the chief food was aspen, which once was abundant around the small lakes in the lower end of the basin where the colony was situated. By 1940, most of the aspens had been cut.

Fresh sign, apparently of one beaver, was found on Clear Lake, 6 miles south and one mile west of Pine Creek Basin, on September 5, 1940. This animal had built a small, loosely constructed house of willow and aspen sticks in a dense clump of willows on the south shore of the lake. One side of this house was crowded against a large yellow pine, while the opposite one extended into the water. The lake, which is about 500 yards long and 150 yards wide, was bordered by a thin fringe of aspens, willows and cottonwoods (fig. 7). The animal had felled 15 aspens and 5 cottonwoods from 2 to 6 inches in diameter, and a small amount of willow. In addition, several fir and aspen trees had been girdled. Because none of the cuttings around the lake appeared to be more than a few months old, it was judged that the beaver had been there only a short time. Possibly it migrated to Clear Lake from the colony in Pine Creek Basin, perhaps by crossing from Pine Creek Basin into Mill Creek and traveling down Mill Creek to Clear Lake.

In addition to the active beaver colonies in Modoc County, abandoned sites of colonies were found on the South Fork of Willow Creek (3 miles south of Crowder Flat Ranger Station), on Holes Creek, Fletcher Creek, Jack Swamp, Dismal Creek, Davis Creek, Joseph Creek, Upper Lassen Creek, the Pit River, Emerson Creek,

Bear Creek, the south fork of East Creek, and on the lower part of Pine Creek southeast of Alturas. Judging from the extensive decay in cuttings, some of these old colonies had been unpopulated for many years.

A colony of 2 animals was found on Bridge Creek, about one mile southwest of McCoy Flat Reservoir, in Lassen County. These beavers were utilizing small willows, and one small dam had been built by them.

Two colonies were found on the Susan River in Lassen County. One of these contained an estimated 5 animals. It was 3 miles east and $2\frac{1}{2}$ miles south of Westwood Junction. The other, a colony of 3 animals, was about 2 miles above this. The Susan River carried only a trickle of water where the upper of these two colonies was located, and a short distance above the colony the stream was dry, save for a few scattered pools. Nevertheless, at the colony there was a dam 25 feet wide and 4 feet high that backed the water for 300 yards into the main stream channel and adjacent sloughs to form a deep, stagnant pool in the flat meadow. A



FIG. 7. Clear Lake, in the Warner Mountains of Modoc County, where a migrant beaver (probably from Pine Creek Basin) has become established in the willow thicket shown on the right side of the photograph. September 5, 1940.

dense growth of willows and some aspens bordered the river channel at the site of the colony, and both kinds of these trees were being used by the beavers for food.

In Plumas County Hensley found a colony of 4 animals living on Indian Creek, about one mile south of Crescent Mills. A colony of 6 nonnative beavers planted in 1934 on Rowland Creek in Plumas County, 3 miles west and 1 mile south of the Meadow View Ranger Station, by the summer of 1940 had increased to about 22 animals.

In addition to the inhabited colonies found in Lassen and Plumas counties there were signs of abandoned colonies at points on the Susan River about $4\frac{1}{2}$ miles below Silver Lake in Lassen County, on Wolf Creek about 4 miles northwest of Greenville, on Thompson Creek about 6 miles below its headwaters, on Ramelli Creek, and on Little Last Chance Creek about 8 miles below the mouth of Rowland Creek in Plumas County.

It is not known whether the inhabited and abandoned sites below Silver Lake, on Bridge Creek and the Susan River in Lassen County, and on Indian

Creek, Wolf Creek and Thompson Creek in Plumas County were established by migrants from the group planted on Rowland Creek, if they were established by remnants of native stock, or whether they were established by introduced Sonora and golden beavers that are thought to have escaped from a beaver farm once operated on Indian Creek, near Taylorsville in Plumas County. It seems most probable that these colonies, particularly those in Lassen County, came from native Shasta beaver stock. The fact that beaver cuttings were found at widely separated points, namely, near Silver Lake, on the Susan River and on Wolf and Indian creeks, suggests that the beavers that left the cuttings did not come from Rowland Creek, because the colony on this stream is in another drainage nearly 40 miles air-line from the nearest of the other colonies. Furthermore, the fact that some of the cuttings in these active and abandoned colonies were well on the way to decay indicates that the colonies are several years old—probably too old to have been made by migrants from Rowland Creek, where beavers were introduced only in 1934. Probably, however, the abandoned colonies on Ramelli Creek and Little Lost Chance Creek were once inhabited by animals that emigrated from the colony on Rowland Creek. This probability is supported by the relative newness of the cuttings found at these places as compared with some of those on the more distant Susan River.

A planted colony of 4 beavers is located on the headwaters of the Upper Truckee River in Eldorado County. These animals were originally planted on Meiss Meadow, but most of them have since moved into the outflowing stream below, and within 4 miles of, the site where they were originally released. Another planted colony of 4 animals is situated about a half mile below Wheats Meadow in Tuolumne County, and there is an introduced colony containing an estimated 6 beavers on Dardanelles Creek, about 2 miles southeast of the colony on Wheals Meadow. Scattered old cuttings, made by animals that apparently wandered from the lots released on Wheats Meadow and Dardanelles Creek, were found on Highland Creek and Dome Rock Creek.

Beaver Colonies of the Great Valley of California

The Great Valley of central California today, as in the past, contains the major part of the State's beaver population. Most of the animals are in the delta where the Sacramento River, flowing from the north, and the San Joaquin River, flowing from the south, join to empty into Suisun Bay. The rest of the golden beavers in this part of the State are on the parts of these streams and their tributaries above the delta proper. In an effort to gain a rough estimate of the number of animals inhabiting these watercourses, the parts that were known or thought to contain beavers were either traversed by boat or examined from land. The lower courses of the Merced and Tuolumne rivers, most of the San Joaquin River, and most of the channels and sloughs in the delta were examined from a boat. Inspection from land was made of the remainder of the streams suspected of harboring beavers in this part of the State.

According to J. C. Pearson, Assessor of Yuba County, there are two colonies of beavers on Plumas Lake adjacent to the Feather River, about 7 miles below Marysville in Yuba County. Judging from the description of the beavers' activities, each colony contains at least 4 animals. Pearson states that these beavers dam up drainage ditches that are 20 feet wide, and even though such dams are destroyed by the ranchers in the vicinity, the beavers usually repair them within a few days.

There are two colonies about one mile apart, the upper with 5 and the lower with 3 animals, along the Feather River at a point west of Río Oso. The beavers of each colony had felled a large number of willows and a few cottonwoods; the upper colony had cut 117 willows over 2 inches in diameter along a 200-yard stretch of bank, as well as a large number for a quarter of a mile above and below this central concentration. No indication of further activity was found along the Feather River, nor were any signs found along the Yuba or American rivers. The only known inhabited colony on the Sacramento River above the delta was found by Hensley at a point $6\frac{1}{2}$ miles west of Chico, in Butte County.

Beavers planted in 1938 on Ragg Creek, a tributary of Putah Creek, between Winters and Monticello in the Coast Range, have increased in number and spread into Putah Creek. About 6 animals live on Ragg Creek within the first 2 miles above its mouth, and 20 on Putah Creek between Monticello and Red Bud Park

in Napa County. Nine beavers planted on Putah Creek at a point about 7 miles above Monticello in the same year apparently have not increased their numbers.

According to Captain John O'Connell of the Division of Fish and Game, beavers once occurred as far up the Mokelumne River as Campo Seco. The writer's examination of this stream in 1940 revealed no fresh beaver sign; only a small amount of old cutting on willows was found. This was at a point about 2 miles above Camanche. Ranchers living along the river said that beavers were becoming increasingly common in the vicinity of Camanche until 1925, when the trapping season was opened. Since then they have been unknown.

The area known as the delta region is roughly 40 miles long and 15 miles wide. Before it was reclaimed for agricultural use it was a flat plain, frequently inundated by high tides from the sea and by flood waters from the rivers. Thousands of acres of tules covered this area, and these, as they died and were replaced by new plants, gradually decomposed and formed a fertile peat soil. Because of the extreme fertility of this soil a network of levees was built to confine the tide and flood waters to restricted channels or canals so that the land thus protected from flooding could be farmed. These reclaimed areas, called "islands" or "tracts," vary in size from a few hundred to 20,000 acres.

Grinnell, Dixon and Linsdale (1937, p. 708) infer that beavers became less abundant in the delta after that region was reclaimed. This probably was the case over the area as a whole, but according to Hiram P. Ward, a former market hunter and trapper, beavers became more abundant in the low central part of the delta after the land was reclaimed. He attributes this change in the beaver population to the fact that before the levees were built the frequent flooding of the tules prevented beavers from living in the lowest parts of the delta, except in the few areas there that were high enough to escape flooding. Those beavers that did live in the interior of the delta built houses rather than burrows in banks. Ward said that he often hunted and trapped along the maze of cattle trails that ran through the tules before the area was reclaimed. Even though he often traveled for many miles through such country he seldom saw beaver sign. With the construction of levees, however, beavers became many times more plentiful in the central part of the delta, because the levees then provided refuge in times of flood.

Beavers in the delta apparently wander from place to place along the canal banks, and do not as a rule live permanently in any one spot. This habit has been noted by several of the licensed beaver trappers now working there, and my own observations tend to support this view. The trappers said that even though one area may not have a beaver population today, it might have several animals living in it tomorrow. Consequently, to make worthwhile catches in their traps, these men patrol the channels in quest of fresh beaver sign. In one instance I visited a slough abandoned by beavers where the large number of old slides indicated that the animals had once been plentiful. On returning to this same place about three weeks later I found much fresh sign, indicating that beavers had reestablished themselves there in my absence. The wandering of beavers in the delta probably results in part from trappers molesting the animals. Also, many of the channels are often navigated by relatively large commercial boats and barges which may disturb the beavers and cause them to move about. In any case the movement of animals does not appear to be caused by any depletion in the supply of food, since tules and willows were plentiful even in places abandoned by beavers.

In 1940, most of the 656 beavers estimated to live in the delta were concentrated in its central part; the population was less dense toward the margin. At the time of the survey there were an estimated 176 animals living along the canals and channels adjacent to the following reclaimed areas: Woodward Island, Lower Jones Tract, Mildred Island, Mandeville Island, Quimby Island, Rhode Island, Bacon Island, McDonald and Henning tracts, Medford Island, Rindge Tract, Holland Tract, Bethel Tract, Franks Tract, Webb Tract, Venice Island, Empire Tract, King Island, Victoria Island, Coney Island, Roberts Island and Union Island. Within this area sign was most plentiful in the lower section around Mandeville and Quimby islands.

Outside this central area beavers were most abundant in the northern part of the delta. There they were most abundant in Cache, Shag, Lindsey, Prospect, Miner and Sutter sloughs, although some were present on Liberty Cut as far north as Lishon. An estimated 35 animals were on the upper part of Lindsey Slough, 20 on Cache Slough, 10 on Shag Slough, 10 on Prospect Slough, 20 on Miner Slough, 6 on Liberty Cut, and 20 on Sutter Slough. On the Sacramento

River the only fresh signs were at points one and two miles above the confluence with Cache Slough where about 3 beavers were working at each place. There was much fresh sign on Sycamore Slough where an estimated 15 animals lived along a 3 mile stretch of channel. On that part of the San Joaquin River north of the central area, sign of an estimated 6 beavers was found along the north bank opposite Jersey Island.

The remainder of the beavers in the delta were along the sloughs to the west and south of the central area. There was sign of about 15 beavers on the slough bordering the west side of the Palm Tract. Another concentration of about 20 animals was found on Old River and the west end of Paradise Cut near the east end of the Grant Line Canal.

Along the San Joaquin River above the delta the uppermost sign was found about 5 miles below Friant, where 4 animals were living. About 2 miles farther downstream a colony of 5 more beavers was located. The next sign on the San Joaquin was a scattered collection of old cuttings about 2½ miles below Herndon in Fresno County. No indication of recent activity was found at this place. Fresh cuttings on willows were scattered along an 8-mile stretch of river immediately above Mendota Dam. Twenty-three fresh slides, along with cuttings on small willows on a half-mile strip of river bank, about 3 miles above the dam, indicated that probably 4 animals were living there. Old workings were found below the dam all the way to the river's mouth, but in the part above the delta these were few and widely scattered. A lack of fresh beaver workings between Mendota Dam and the mouth of the Merced River probably can be attributed in part to the fact that at the time the survey was made (October, 1940), the dam was being repaired and, except for a small amount of irrigation drainage, no water was allowed to pass into the channel below.

Below the Mendota Dam there was fresh sign just below the confluence of the Merced River, near Crows Landing. There the work of what I judged to be 2 animals was found. Additional fresh sign was concentrated in three places between this point and the mouth of the Tuolumne River. Each concentration was small and appeared to be the work of only one animal. The work of 3 animals was found along the San Joaquin River west of Yermalis, and the sign of 4 additional beavers was located around the confluence of the Stanislaus and San Joaquin rivers.

In the autumn of 1940 beavers were active on several of the tributaries of the San Joaquin River. Some of the tributaries that in the past supported colonies of beavers apparently now lack them. Fresh sign of beavers was found scattered for 8 miles along Little John Creek immediately above Eugene in Stanislaus County. Seven beavers planted along that creek in 1939 had, by the time this survey was made, increased to an estimated 10.

On the Stanislaus River, which once was heavily populated by beavers according to ranchers living along the stream, the only fresh beaver sign found was along the lower 10 miles, where there was evidence of the presence of 6 animals. The sign along this part of the river consisted of scattered fresh cuts on willows and 15 recently used slides. A small amount of old cutting on willows also was found along this stream at a point about 4 miles above Oakdale.

The Tuolumne River a few years ago supported only a small, scattered beaver population, according to the statements of residents living along the stream. Recently, however, beavers have been increasing until in the summer of 1940 there were an estimated 37 animals living along its banks. The uppermost sign was found about one-half mile below La Grange, where an estimated 3 animals were working along a half-mile stretch of river. The next group of fresh cuttings was seen about 3 miles below La Grange where 5 animals had felled more than 150 willows. About 1½ miles below this colony there was a colony of 3 additional beavers. At points about 7 and 10 miles below La Grange two colonies, each with 4 animals, were found. Along a two-mile stretch of river opposite Waterford there was sign of 5 more animals, of which 2 were above the highway bridge, located ¼ mile south of the town, and 3 below the bridge. At a point about 4 miles below Waterford a concentration of fresh cuttings indicated the presence of 4 beavers, while 3 miles farther down there was sign of another colony of four. No other fresh sign was found on the Tuolumne River until a point about 5 miles above its confluence with the San Joaquin River was reached. There, along a mile stretch of river there were two concentrations of fresh cuttings, one the work of 3 and the other the work of 2 animals. No fresh work was found on this stream below this point. On the Tuolumne River, in addition to the fresh beaver work, old work was seen

in many places along its banks, but this, like the fresh sign, was most common between La Grange and Modesto.

The Merced River and its adjacent sloughs in the Autumn of 1940 supported about 74 beavers. The greater number of these were between Merced Falls and Livingston. The uppermost colony, containing an estimated 4 animals, was just below the diversion dam about 4 miles downstream from Merced Falls, and a small colony of 3 was found about one mile below Snelling. Another colony was 5 miles below Snelling immediately below the point where the "Old River Channel" begins, and contained 3 beavers. The "Old Channel" is a slough about 5 miles long that formerly carried the main flow of the Merced River, but that now serves as an irrigation ditch to supply water for irrigation to several farms along its course. A plentiful supply of cut-bail and willow growing along its banks makes it an excellent habitat for beavers. An examination of this channel revealed a total of 9 beaver dams and a large amount of fresh cuttings and slides that were made by about 25 animals. On the main channel of the river there was a colony of 1 animal where it is rejoined by this "old channel." About 2 miles below this colony another group of fresh cuttings, apparently made by 4 animals, was found. About 2 miles above the mouth of Ingalsbe Slough there was a colony containing 4 beavers, and on Ingalsbe Slough another of 4 animals about a mile above its confluence with the main channel. About 1 mile above the main channel there was a third colony of five.

Midway between the mouths of Ingalsbe Slough and Dry Creek a scattered group of fresh workings indicated the presence of 3 beavers. On Dry Creek there were workings of 4 animals along the first mile above its mouth. About one mile below the mouth of Dry Creek, a colony of 4 more animals lived on the main channel of the river. The next fresh sign was about 3 miles below the mouth of Dry Creek, where there were indications of the presence of one beaver. Midway between Cresssey and Livingston another small group of cuttings indicated the presence of 2 additional beavers. No further sign was found along the Merced River until a point was reached about 4 miles above its confluence with the San Joaquin River. Scattered fresh workings between that point and the mouth of the river indicated that probably 1 animal was living there. In addition to the fresh beaver workings, large amounts of old cuttings were found along the Merced River, but their distribution in general coincided with that of the active beaver colonies.

Beaver Colonies of Southeastern California

In southeastern California there are about 317 Sonora beavers, all native. Thirty-two of these were found in the Imperial Valley, 13 in the irrigation canals and sloughs of Palo Verde Valley and 272 along the Colorado River. Of those on the Colorado River, 129 were on the California side and 141 were on the Arizona side. For the purposes of this report, those beavers living on the Arizona side of the river are included as a part of the California population.

In April and May of 1940, that part of the Colorado River forming the southeastern boundary of California was navigated by Leo Rossier of the Division of Fish and Game and the writer. In this "water-distance" of approximately 250 miles there were few stretches of more than 2 or 3 miles where some fresh sign was not found.

Seventeen beavers were living between the northern point where the Colorado River touches California and the town of Needles, California, a river-distance of about 15 miles. Ten of these were on the Arizona side and 7 were on the California side of the river. Most of the beaver sign was about 8 miles north of Needles where along one mile of low bank there was an average of one fresh beaver slide to every 100 feet. In general, the Arizona bank along this part of the river appeared to be capable of supporting more beavers than did the California bank.

On the main channel between Needles and Topock, Arizona, a river-distance of 15 miles, there were 16 beavers, 6 being on the California side and 10 on the Arizona side. The river there had numerous adjacent sloughs on which additional beavers were living. All of these sloughs were not examined carefully, but judging from the sign found on the sections of them which we visited, at least 20 beavers were living along the sloughs on both sides of the river in addition to those on the main channel. Thus, between Needles and Topock there were on the sloughs and on the main channel about 36 animals at the time this survey was made.

Fourteen animals were living between Topock and Parker Dam, a river-distance of 42 miles. Six of these were on the California side and 8 on the Arizona side of

the stream. At Topock the river enters Mohave Canyon. For about 10 miles the river flows through the narrow, rocky canyon bottom and then enters the upper end of Lake Havasu, which was recently formed in Chemehuevi Valley by the Parker Dam. Twelve of the 14 beavers were evenly distributed along both banks between Topock and the head of the lake, although the amount of available food there was insufficient for their continued maintenance. On this part of the river there are numerous small bays, formed where the mouths of the steep-walled side canyons open into the river. Most of the few willow trees growing in the mouths of these canyons had been cut by beavers. One beaver house was in the shallow water near the middle of one of these bays (fig. 8). Another house, constructed of willows and arrowweed sticks, rested against a steep rock wall at the water's edge. The points nearest this house where willows and arrowweeds grew were 150 yards downstream on the same side of the river and 200 yards upstream on the opposite bank; the animals must have exerted considerable effort in gathering material for building the house. Probably the beavers migrated here when the water backed up from

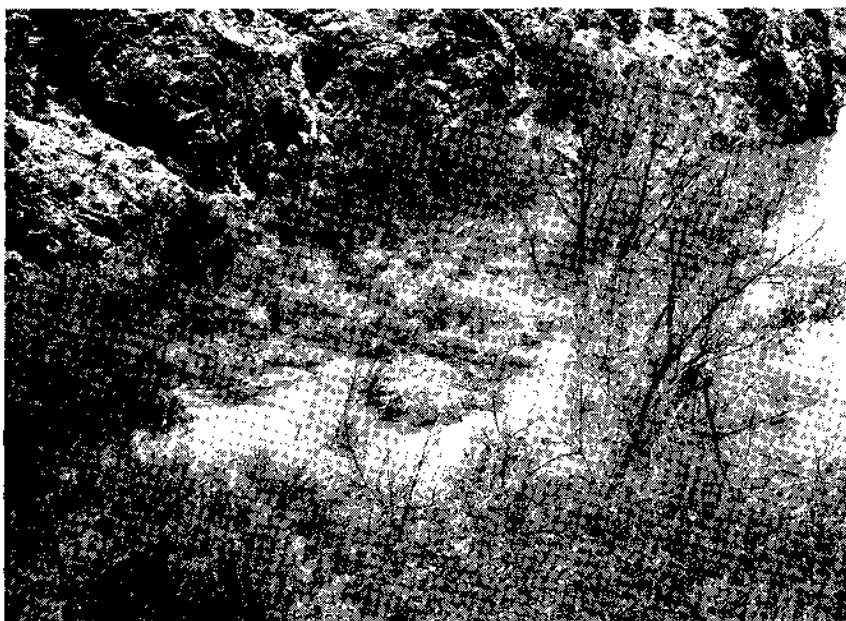


FIG. 8. Beaver house in the shallow water of a small bay beside the Colorado River in Mohave Canyon. Photographed May 3, 1940, 3 miles below Topock, Arizona.

Parker Dam and forced them to leave their former homes along the more densely wooded stretches of the stream in Chemehuevi Valley. These beavers were utilizing the available food faster than it was being produced, and therefore probably will be forced to migrate farther upstream in the near future.

On Lake Havasu, which is about 32 miles long and from one-half to 5 miles wide, there were 2 animals living on the Arizona shore about 2 miles above Parker Dam. Additional scattered beaver sign was found among the few small cattail patches that fringed the lower 12 miles of lake shore, and also some sign was found near the head of the lake about 12 miles below Topock, but these workings appeared to have been made by wandering individuals, and not by resident animals. Willows or other types of vegetation suitable for beaver food had not yet had time to become established on the barren shores of the newly formed desert lake in a quantity sufficient for the support of many animals. Perhaps the scarcity of food explains why this body of water had such a small beaver population in the spring of 1940.

Twenty-three beavers were living between Parker Dam and Earp, California, a river-distance of 18 miles. Six of these were on the Arizona side and 17 were on the

California side. Most of these animals were concentrated along a 4-mile stretch of river midway between Cross Roads and Earp.

Between Earp and the base of Riverside Mountain, a river-distance of about 20 miles, there were 22 animals, of which 13 were on the California side and 9 on the Arizona side of the river. Most of these animals were living in 3 colonies at points about 5, 13 and 17 miles below Earp. The Arizona side of the river between Earp and Riverside Mountain in general lacked the continuous heavy willow growth found along most of the California side.

Twenty-seven animals were found between Riverside Mountain and Blythe. Twelve of these were on the California side and 15 on the Arizona side of the stream.

From Blythe to a point on the river nearest Palo Verde, California, a river-distance of about 26 miles, there were 29 beavers, of which 15 were on the California side of the channel. For the first 12 miles below Blythe, all of the beavers appeared to be in 5 colonies along the Arizona bank, although the California bank



FIG. 9. Many willows cut by beavers. Colorado River, 12 miles below Blythe. May 7, 1940.

had an equal amount of food available for them. Beavers in the lower of these colonies had recently cut more than 400 willow trees from one to 4 inches in diameter along a quarter-mile length of river bank. In addition there were more than 1,200 older-cut trees at this place. A part of this bank where the willows had been heavily utilized is shown in figure 9. Except for an individual animal living at mile 13, and one at mile 26 on the Arizona side, all of the remaining beavers between Blythe and Palo Verde were scattered along the California side of the river. Between miles 13 and 25 on the Arizona side, the vegetation on the bank was of old willows, cottonwoods and arrowweeds. There were some old cuttings there, but no sign of recent activity. At a point about 15 miles below Blythe the river spread, and in places a part of the water flowed through sloughs that branched from the main channel. Young willows and tules formed the main vegetation along the California bank there. This condition continued for several miles below Palo Verde, where the channel again became more restricted.

The sign of 29 beavers was found between Palo Verde and Picacho, a distance of about 34 miles. Of these, 17 were on the Arizona side and 12 on the California side of the river. Most of these animals were concentrated in two

localities at points about 15 and 32 miles below Palo Verde. At the upper locality, a large concentration of over 1,000 freshly cut willows and 100 slides were found along one mile of bank. Between miles 15 and 30 the river flowed through a restricted bottom. There the willow growth was less luxurious, and in places where the desert hills extended down to the river's edge the only bank growth was arrowweed. At a point about 28 miles below Palo Verde the first effects of the backing up of the river by Imperial Dam became apparent. There the river bottom widened and, because the slowing of the water had caused a deposition of silt that filled the main channel, the water spread into numerous sloughs, along which were growing tules, catrails and willows. A short distance farther down some of these sloughs overflowed their banks and in places formed continuous sheets of water that covered the willow-grown river bottom.

From Picacho to Imperial Dam, a distance of 19 river miles, there were 30 beavers, of which 11 lived on the California side and 19 on the Arizona side of the river. The marshy condition, first apparent a few miles above Picacho, continued to a point about 6 miles below, where the deposition of river silt had been heaviest, and a large sand bar had formed. This sand bar diverted the river water from the main channel across the mesquite and willow thickets growing in the former river bottom, so that often the river consisted merely of a wide, shallow sheet of water that flowed slowly through the wooded bottom. In navigating this part of the river, it was necessary for us to follow the deeper channels and at the same time to pick our way through the flooded mesquite and willow thickets. The water in many places was spread in this manner for a distance of one-half mile on either side of the old channel. This condition extended for about 6 miles, when the water became deeper and a more definite open lake was apparent.

Between Picacho and Imperial Dam beaver sign was most common along the old, sand-filled river channel between miles 6 and 12 below Picacho. There the most recent sign of intensive activity was on the Arizona side, where 3 occupied houses were found in the shallow water among willows and mesquite. Two of these houses were inhabited by families of beavers, judging from the presence of large and small tracks on mud-bars around each, while one was apparently the home of a single animal. There were numerous fresh tracks on the California side of the old channel, and in the mud-bars in the old channel itself, but no houses were found there. The flooded nature of the ground made it so difficult to investigate the area between 6 and 12 miles below Picacho that we were unable to examine more than one-third of the possible beaver habitat. Therefore, since we found evidence of 9 beavers in that part of the area examined, probably about 27 animals lived between miles 6 and 12 below Picacho. The numerous fresh tracks found in that area further indicated that the population there was greater than nine. The fact that the Arizona side of the river supported more willow growth than the California side leads us to estimate that possibly two-thirds, or 18, of the 27 animals between miles 6 and 12 were living on the Arizona side.

A small house, apparently inhabited by one animal, was found close against a rock wall on the Arizona side about 13 miles below Picacho. No additional beaver sign was found between this point and Imperial Dam, probably because the recent filling of the lake had destroyed most of the food suitable for beavers and new growth had not yet become established on the shores of this newly formed desert lake.

There were 43 beavers living along the Colorado River between Imperial Dam and the California-Baja California boundary, a river distance of 22 miles. Twenty of these were on the California side and 23 on the Arizona side. Fifteen of these beavers lived on the 5-mile section of river between Imperial Dam and Laguna Dam, where there was available a large number of small willows adjacent to deep, quiet water (fig. 10).

Below Laguna Dam, fresh beaver cuttings were distributed more or less uniformly as far south as the International Boundary, but old cuttings were much more numerous than new. The fact that there was a higher proportion of old cuttings to new cuttings along the river below Imperial Dam, whereas at most other places on the river the amount of new sign was greater than old, suggests that the animals have been much molested in the area around Yuma and have not been able to reestablish themselves as rapidly as they otherwise might have done.

In the spring of 1940 there were 13 animals living along the irrigation canals and drains in the Palo Verde Valley, which is situated along the Colorado River.

Of these, 6 were found along 11 miles of the main canal between Blythe and the canal intake, 8 miles north and 5 miles east of Blythe. Sign of recent activity was found all along this water-way, although most was in the first 3 miles below the intake. The work of what appeared to be a single animal was found along a canal at a point about 4 miles north of Palo Verde. Signs of the remaining 6 beavers were found on the lower 3 miles of the main drainage canal, called the Outfall Drain, between a point 2 miles below Palo Verde and the point where this drain flows into the Colorado River. There was considerable old sign along a canal about 4 miles east of Palo Verde, and also along a canal about 2 miles directly north of Palo Verde, and along canals in the vicinity of Rannels and Ripley. Probably there are additional beavers scattered along the many canals in the Palo Verde irrigation system, but no sign of these was found.

Before the Imperial Valley was developed for agricultural enterprises, the area between Salton Sea and the International Boundary was a barren desert without permanently wet areas where beavers could live. The Alamo and New

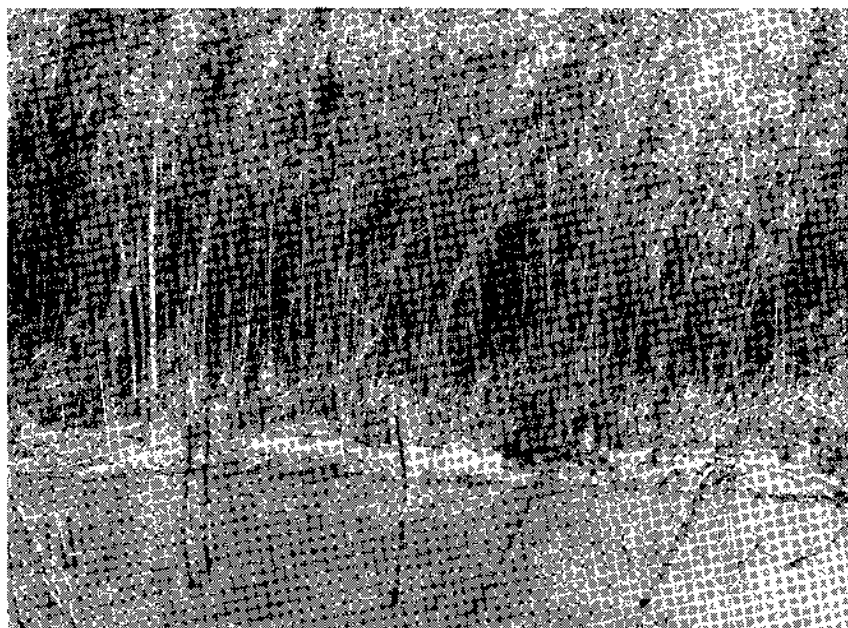


FIG. 19. Dense willow growth on the California bank of the Colorado River between Imperial and Laguna dams, where beavers were relatively abundant. April 21, 1946.

River channels carried water only at certain times of the year, and the lakes formed by them usually dried up in summer. With the construction of irrigation and drainage canals, beavers in 1911 began to invade this area from the Colorado River via two routes, namely the main Imperial (East Highline) Canal and the Alamo River on the east side of the Valley, and the Black Butte (West side Main) Canal on the western side of the Valley (Grinnell, Dixon, Linsdale, 1937, p. 727). Thus, the settlement of Imperial Valley by white men has brought about conditions making it possible for the Sonora beaver to extend its range beyond that formerly occupied. Dixon estimated that there were 100 beavers in Imperial Valley in 1921.

Trapping between 1925 and 1933 and a severe water shortage in the Valley in 1934 led to a sharp decrease in the beaver population. Since 1934 beavers have gradually increased until in the spring of 1940 there were in the Valley about 32 animals, most of which lived along the lower part of the Alamo River.

The Alamo River rises from the Colorado River as an irrigation canal at Andrade, California, just north of the United States-Mexican Boundary. From

there it flows south and west through the artificial Imperial (or Alamo) Canal in the northern part of Baja California, where a part of its water is used by the Mexican farmers to irrigate the rich Colorado River delta lands. The river enters California from Mexico a few miles east of the town of Calexico, and flows north for about 60 miles into Salton Sea. In the part of Imperial Valley north of the International Boundary the river flows in its natural channel and serves as one of the main canals for supplying water in the valley; the other main canals in the United States branch from this stream before it enters the United States. In California the banks of the Alamo River are lined with arrowweeds, canes, cattails, tules and willows. The willow and cattail growth is heaviest in the lower part of the stream before it enters Salton Sea.

In April of 1940, Robert Hart, of the California Division of Fish and Game, and the writer examined this river by boat along its entire course in California. Our boat was launched at the California Baja California Boundary, from where we floated downstream (north) to the mouth of the river. The first fresh sign of beavers was found immediately above Holtville; three fresh slides and a small amount of fresh cutting on willows indicated the presence of one animal. About 5 miles below this, at a point due east of Heber, a small amount of old cutting was located. No additional fresh sign was found until we reached a point about 4 miles east and 2 miles south of Brawley. There a small amount of fresh cutting, tracks, and two slides along a willow-grown bank indicated the presence of another animal. Additional fresh cuttings were found at points 4 miles east and 2 and 3 miles north of Brawley, each of these groups of cuttings apparently having been the work of single animals. No further fresh sign was located between the lower of these points and Wiest Lake, although old sign was not uncommon all along this part of the river. Three concentrations of fresh cuttings were along a half-mile stretch of river within the first mile below Wiest Lake. The numerous slides and the large amount of cuttings on willows and cattails indicated that at least 5 animals had been active there. About one-half mile farther downstream, on the Finney Gun Club, and on the southeast corner of the Imperial Game Refuge, concentrations of fresh sign indicated the presence of 5 additional beavers. Between this point on the Refuge and the Brawley-Calipatria highway bridge, 7 miles north of Brawley, the sign of 2 more beavers was found. About one-half mile below the highway bridge a small group of fresh cuttings on willows showed one beaver to be living there. About a half mile farther downstream a larger concentration of sign indicated the presence of 4 more animals. Both of these groups of cuttings were on the Imperial Game Refuge. Below the Refuge the only fresh beaver sign was at a point about 4 miles northeast of Calipatria, where scattered fresh cuttings of willows and cattails indicated the presence of one animal.

In general, the beaver population of the Alamo River was concentrated along the lower part of that stream in the vicinity of the Imperial Game Refuge between Brawley and Calipatria. This probably was partly the result of the added protection received by animals living on the Refuge, and also because that section of the river was especially favorable for beavers from the standpoint of available food supply. Numerous old cuttings along almost every mile of the stream between Wiest Lake and the mouth of the river indicated that for several years beavers had been present there in larger numbers than elsewhere along the stream.

The New River, which flows roughly parallel to the Alamo River in Imperial Valley and empties into Salton Sea, was likewise examined from a boat. This river serves as a drainage canal for the irrigation districts in the United States and Mexico, and flows into the United States at the town of Calexico. No fresh beaver sign was found on this stream, although there was a small amount of old cuttings along the upper part between Calexico and Seeley.

The Imperial Irrigation Company has built approximately 1,800 miles of supply canals and 1,200 miles of drainage canals in the Imperial Valley Irrigation District. Most of these are intermittently allowed to become dry and thus are unsuitable for beavers, but some of them carry a relatively permanent flow of water enabling beavers to live along them. A few beavers are scattered about the Imperial Valley along such canals, but apparently the animals are for the most part wanderers that do not build permanent homes. This is probably because the canal banks are patrolled by workmen whose business it is to locate and discourage the activities of muskrats, pocket gophers and beavers, and because much of the suitable beaver food that grows along the canal banks is cut and destroyed to keep the canals free from growth that would impede the flow of water.

Evidence of the presence of beavers in the canal system was furnished by several canal-gate tenders who said that beaver-cut sticks often float down the canals and lodge against the canal gates. At the number 8 heading on the West Side Main Canal, $3\frac{1}{2}$ miles northwest of Imperial, Mr. W. W. McCarty, the gate-tender there, had piled two dozen beaver-cut sticks beside the canal gate against which they had lodged. According to him, he usually removed one or more such sticks from the canal gate every day. He further said that on January 26, 1940, an adult beaver was accidentally killed at this heading (skull recovered by the writer), and at the time he was interviewed (March 21, 1940) reported another beaver working in that vicinity (fig. 11). According to Ben Robertson, a hydrographer with the Imperial Irrigation Company, 2 beavers were found land-locked in a sump near Foxglove Heading on the West Side Main Canal a few years ago. One of these was placed in the San Diego Zoo, and the other animal disappeared.

A small amount of fresh beaver cutting was found by the writer along the Elder Canal about one mile below Dahlia Heading on the Central Main Canal, near



Fig. 11. West-side Main Canal in the Imperial Valley, where a Sonora beaver was taken on January 26, 1940. March 21, 1940.

El Centro, and Ralph Thompson, the hydrographer at Dahlia Heading, found a dead beaver near this same place in the autumn of 1939. A small amount of old beaver sign was found along the East Highline Canal, but no fresh workings were found. Nevertheless, beavers probably are present there. Mr. Clayton Boyd, the hydrographer at Out Heading on this canal, said that in the winter of 1939-40 he found in a muskrat trap set near this heading the toe of a beaver that had escaped. Also, in the spring of 1940 he found two dead beavers floating in the water, but thinks it possible that these floated down from Mexico.

In the time at my disposal it was impossible to examine carefully all of the canals in the Imperial Valley, although most of the main canals were examined. Because of their wandering habits, beavers in these canals usually leave but little evidence of their presence. Therefore, it is probable that some beaver sign was overlooked. Even when this possibility is taken into account, it seems unlikely that there were more than 10 animals living on the entire United States part of the Imperial Valley canal system in the spring of 1940.

According to M. J. Dowd, Chief Engineer and General Superintendent of the Imperial Irrigation District, beavers are less plentiful in the Imperial Valley than

they were prior to 1934. In that year there was an acute shortage of water in the Valley; most of the canals became dry, and the Alamo and New rivers carried only brackish seepage water. The gates on the main canals were sealed by the irrigation company, and the water that accumulated at them was pumped and hauled to water livestock. This condition led to a great decrease in the population of beaver throughout the Valley, while on New River the beaver population, which previously had been relatively large, disappeared. The statements of ditch-tenders, hydrographers and other employees of the water company interviewed, corroborate the statement that beavers were more plentiful in Imperial Valley prior to 1934 than after that date.

Apparently beavers are now more plentiful in the Mexican canals of the Imperial Irrigation District than they are in the canals north of the boundary. Alfonso Perez of the Mexican Division of the Imperial Irrigation District, and in 1940 stationed at Mexicali, Baja California, said that beavers were not uncommon along the Imperial Canal between Andrade and a point 67 kilometers west thereof where the East Uighline Canal arises. According to Perez, groups of fresh beaver cuttings can be found at an average of every two miles along this part of the Imperial Canal. Beavers are also common on the seepage lakes that stand beside this canal. Perez said also that there are a few beavers on the Solatera Canal at kilometers 18 and 25 below the heading, and many on the abandoned Bee Canal about 20 miles southwest of Andrade.

PRESENT ECONOMIC STATUS OF THE BEAVER IN CALIFORNIA

Because of their scarcity, beavers as a fur resource in California now are relatively unimportant when the total of fur sales is considered. Only a few are trapped each year under special permit. To prevent their extinction, it has been necessary to prohibit the trapping and marketing of their furs throughout the State, except in special instances. Nevertheless, with proper management beavers can be increased to a point where, in certain areas and under certain conditions, their furs can be taken and marketed. When, and if, these mammals become sufficiently abundant to allow limited numbers to be taken, they will probably contribute substantially to the total income from the sale of fur in the State. Although relatively few pelts may then be taken, the average price for such pelts probably would be relatively high compared to the price received for the pelts of many other fur bearers in California. In 1940 the pelts of golden beavers, trapped and sold under special permit, brought about \$10 apiece.

Their proclivity for building dams and digging burrows gives beavers an added economic importance. Beaver dams built across streams raise the water table in the adjacent land. In many places this rise in the water table is sufficient to enable grasses and other forage plants growing in meadows adjacent to beaver ponds to remain green throughout the summer. This condition exists on Marlahan Slough in Scott Valley, Siskiyou County, near the dams built by a colony of introduced beavers. Considerably more forage is thereby provided than would otherwise be there. According to William T. Davidson, the Siskiyou County Road Supervisor living at Fort Jones, who was active in getting the present colony planted in Scott Valley, one reason for planting the beaver colony there was the hope that the animals in damming Marlahan Slough would raise the water table enough to increase the grazing capacity, or to enable hay to be grown on the adjacent land.

Farmers also draw irrigation water from ponds formed by beaver dams, and thus are spared the expense of constructing dams of their

own. One beaver dam on the "Old Channel" in Merced County has been used for this purpose for many years. Because beavers have kept it in repair, the dam has withstood the ravages of many floods.

There is evidence that beavers render a valuable service to stockmen by building dams and holding water in small streams that might otherwise become dry in summer. In such places the conservation of water by the beavers makes it unnecessary for stockmen to remove their live stock from a locality because of insufficient water. According to J. R. Sidwell, who operates a ranch on Ragg Creek in Napa County, where a colony of beavers was planted in 1938, the creek normally became almost dry by mid-summer of each year, prior to the introduction of the beavers. Since that time the creek has maintained a small but steady flow throughout the summers, especially at and below



FIG. 12. A beaver pond on Rowland Creek in Plumas County. Ponds such as this directly provide habitats for trout and other aquatic animals, and indirectly provide habitats for many other forms of animal life. August 19, 1940.

the site of the colony where the dams are located. Because of this conservation of water, he regards the beavers as a valuable asset to his ranch.

A similar situation was noted on Wheats Meadow in the Sierra Nevada where a planted colony of beavers, by building dams below the meadow, helped maintain the flow of water.

The effect of the beavers' activity on other animals may be profound. When a beaver pond is formed, many different types of animals establish themselves in or around it as a result of the diversified habitats offered. The ponds formed along small streams by beaver dams provide places where a greater number of fish of a larger size can exist than would be the case if no dams were present. The water conserved by beaver dams on Wheats Creek was being utilized by live stock, deer, quail, and other wildlife. Trout as long as 10 or 12 inches

were seen in the beaver ponds on Wheats Creek. Because this creek was virtually dry, except for the beaver ponds, it seems that the presence of beavers was instrumental in maintaining the population of fish there. Rowland Creek, in Plumas County, which before the introduction of beavers lacked ponds of sufficient size to support anything but small trout, in the summer of 1940 contained a large number of trout, many of which appeared to be more than 12 inches long. These larger-sized fish were found only in the beaver ponds (fig. 12). A number of fishermen were seen fishing there when Seymour and the writer visited this colony on August 18 and 19, 1940.

Cook (1940, pp. 399-401) is of the opinion that in some instances beavers in New York may be detrimental to trout because the opening of the forest growth around the streams by cutting, and the spreading of the stream by damming, may cause the temperature of the water to be warmed so much by the sun's rays that the trout can not tolerate it. Also, the leaching of submerged litter in beaver ponds may cause the oxygen content of the water to be decreased and the humic acid content increased to a point dangerous to trout.

The increased variety and amount of vegetation which normally grows around a biologically balanced beaver pond furnishes habitats for various insects, many of which are used as food by fish living in the pond. Muskrats, shrews, meadow mice and other small mammals invade the area and become established. Ducks and other waterfowl, as well as many other birds, find nesting sites around the ponds. Thus, the invasion of a stream by beavers may result in an ecologic succession that provides habitats for a diversified fauna and flora.

Where beavers do not build dams but instead live where the water is already sufficiently deep for their needs, the effect on other animals and plants is less. This situation prevails in the Great Valley and in southeastern California, where beavers as a rule live along deep channels or where natural pools are present, and thus the animals in most instances are spared the need of building dams.

By building dams, beavers aid materially in reducing soil erosion in certain areas, especially in some of the mountain meadows where the erosion problem is becoming serious. This was one of the objectives that the forestry officials had in mind when most of the colonies in the Sierra Nevada were introduced. Beavers are not yet definitely established at most of the places where liberated; thus it is too early to judge of the correction or retardation of erosion by the animals in these colonies. In other places, outside California, beavers have reduced erosion to a measurable degree.

Unfortunately, many of the places where erosion is progressing rapidly are places which do not offer the best habitats for beavers. Beavers planted in one of these places would probably move to a part of the stream that offered a habitat more suited to their needs. Such was the case on Meiss Meadow in El Dorado County. The animals were originally planted among willows near the central part of the meadow where erosion was beginning. Instead of locating there, however, most of them moved downstream to a place where erosion was negligible. On Rowland Creek, beavers were planted in a habitat suited to them but where erosion was under way, and they established themselves successfully at that place. Waldo Wood and B. Beard of the Plumas

National Forest have followed the success of the beavers transplanted to Rowland Creek and are of the opinion that they have been successful in reducing erosion.

By no means unimportant is the esthetic value of the beaver, for people generally are much interested in this mammal and its engineering feats. Several of our national parks feature beaver dams that are annually visited by many people. Even the colony on Rowland Creek, remote as it is from any point with a large human population, during our short stay there in August of 1940 was visited by several people who watched for the beavers to appear at dusk.

The activities of beavers may be an asset in some places, and a hindrance to man in others. The golden beaver's habit of digging burrows makes it a definite menace in areas such as the delta, where levees are built to confine water for reclamation purposes or for flood control. In such places the beavers may dig burrows into the levees, thus allowing water to enter and soften their centers. Grinnell, Dixon and Linsdale (1936, p. 707) give an example of how a beaver burrow in a levee might have resulted in the levee's break.

Most of the landowners in the delta are fearful of the damage that beavers might do, and it is this fear, rather than any extensive actual damage, that has prompted the Division of Fish and Game to issue permits for trapping beavers. Some owners in the delta say that heavy implements driven along levees have broken through into beaver burrows. When such an accident occurs, a considerable expense is usually involved in removing the implement and in hauling soil to fill the caved-in burrow.

The Sonora beaver, being largely a bank-dweller, also will damage levees. However, because these animals are relatively uncommon in the system of canals in the Imperial Valley, where they would be most injurious in this respect, they do not constitute a serious problem. Nevertheless, the men employed to patrol the canal banks keep a sharp lookout for signs of beaver damage. According to Alfonso Perez of the Mexican Division of the Imperial Irrigation Company, even where beavers are relatively common along a canal, as they are on parts of the Solfatera Canal in Mexico, they do not do nearly as much damage to canal banks as do muskrats.

Rarely the tree-cutting proclivity of the beaver is detrimental to man's best interests. Beavers have been known to cut and destroy pear and peach trees growing in orchards beside streams. The most recent instance of this kind known to the writer occurred on the Blakesley Ranch, 2 miles east of Empire, in Stanislaus County. In the summer of 1940 beavers living along the Tuolumne River, which borders the ranch, had climbed up a 12-foot bank and felled or girdled 14 peach trees, most of them with trunks about 4½ inches in diameter. Some of these trees were cut as far as 80 feet back from the river. Mr. Perez says that beavers on the Mexican canals are troublesome because they cut willow trees which, in some places, the irrigation company purposely leaves growing along the canal banks to be used for "rip-rapping" the canals. The cutting of aspens by some of the colonies of beavers introduced in the mountain areas of the State apparently is of such an extent that it may destroy all their food of this kind there. If this happens, some of the esthetic value of the beaver will be offset by its having

marred the beauty of groves of aspens, which, however, are among the fastest growing trees.

In certain places the damming of a stream and the subsequent rise of the surrounding water table may be detrimental rather than beneficial to ranchers. Most of the complaint in this respect has come from ranchers living in the vicinity of Snelling, along the Merced River. Beaver dams there, on the ranch of W. L. Means, raised the water table enough to make several acres of land adjacent to them unsuited for growing alfalfa.

Perhaps the complaint most commonly made by ranchers against beavers is that the animals dam irrigation ditches and drains and plug irrigation gates. Complaints of this kind were heard against all three races of beavers in California. In Modoc County, wherever the Shasta

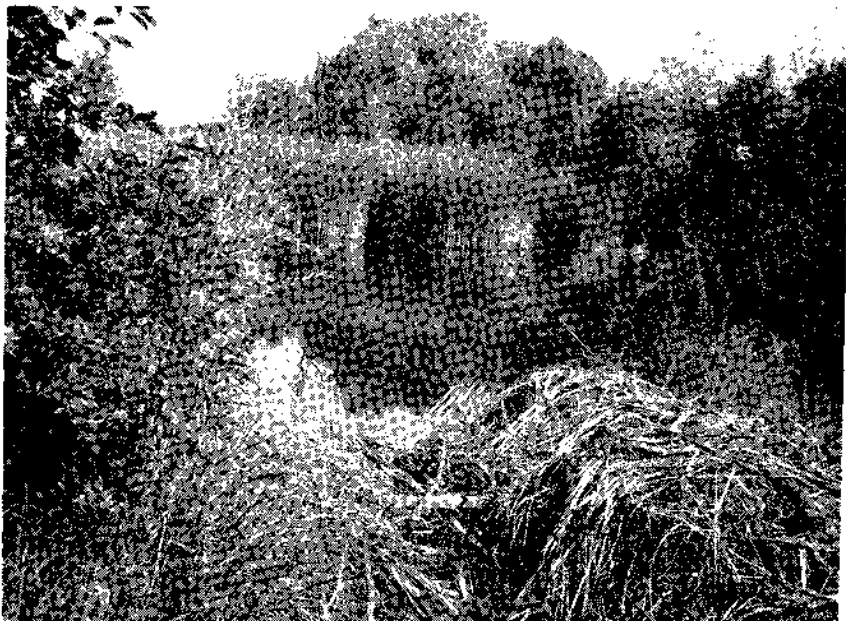


FIG. 13. Irrigation gate plugged by beavers. Photographed on "old channel," near Snelling in Merced County. November, 1940.

beaver lives on irrigated ranches, it causes the farmers annoyance by interfering with the flow of irrigation water. Unfortunately, many of the places in Modoc County offering the best habitat for beavers are now being farmed; thus, as long as the animals are present in the farmed areas of Modoc County, probably this trouble can not be completely eliminated. On the "Old Channel" near Snelling, golden beavers more or less regularly plug irrigation ditches, according to residents there (fig. 13). A considerable expense is involved in the daily clearing of the ditches before each day's irrigation can proceed. Also, considerable water may be "lost" through absorption by the soil where dams spread the water over a wide area. W. J. Ferrel, who owns land along the "Old Channel," was of the opinion that often only 50 per cent of the water turned into the channel at its heading reached the

farms on the lower end. He attributed at least a part of this loss to seepage into the ground from the ponds formed by the beaver dams.

HABITAT REQUIREMENTS

Although the writer looked carefully for differences in the habitat requirements of beavers in different parts of the State, he found them to be similar. Possibly some kinds can tolerate a lower temperature than others, but this possibility remains to be proven.

One requirement of the beaver is a permanent supply of water. When water disappears where beavers live, they will perish unless they are able to migrate to a place where some is present. The beaver is structurally adapted for an aquatic life. The webbed hind feet are adapted for swimming, the under fur is short and so dense as to prevent water from reaching the skin. The broad, transversely flattened tail is used by the beaver as a rudder and as an aid in diving. If confronted by an enemy while far away from water, a beaver though not helpless, is so awkward that it might be unsuccessful in escaping. Therefore, before beavers will permanently inhabit an area, there must be present a permanent supply of water deep enough to cover entirely the entrances to the animals' houses or burrows, or else water so situated that through the building of dams or canals the beavers can make it sufficiently deep to cover the entrances to their homes. By building dams, beavers are able to form pools in streams that otherwise normally would be only a few inches deep. One dam on Rowland Creek was 270 feet long and had formed a pool that was more than 5 feet deep next to the dam.

As a rule, where ponds remain free of ice in winter, beavers require water at least 2 feet deep at the site of their permanent burrows or houses, and they prefer deeper water. In most places where we found beavers, the depth of the water was more than 2 feet at the entrance to the burrow or house. An exception was on Willow Creek in Modoc County, where there was a beaver den in a bank beside a pool only 18 inches deep. Probably the beavers would be unable to survive there in winter, because the temperature then is low enough to freeze the pond solidly. Other colonies of beavers along the creek lived where there were pools much more than 18 inches deep.

Although beavers probably prefer to live along streams where the flow is not subject to frequent severe fluctuations, such a condition seems not to be a critical factor in the animals' habitat requirements. Because of the irregular, and sometimes exceedingly heavy, rainfall in their watersheds, most of the beaver-inhabited streams of California are subjected to sudden fluctuations. This is especially true of the streams along the coast, and in central and southeastern California, where heavy Winter rains sometimes occur. It is also true in the Sierra Nevada, where the Spring run-off is at times sufficient to turn small creeks into torrents. Beavers will not necessarily desert a stream whose flow is subject to extreme fluctuation once they have become established. This is shown by the colony on Putah Creek, which was thriving in 1940 even though that stream is subject to sudden rises during heavy rains. In 1939 the water, which normally is relatively shallow, attained a depth of more than 30 feet in a storm, according to J. R. Sidwell, whose ranch

lies along the creek. Although this flood washed out a dam that the newly established beavers had built, the animals did not desert the area, as proven by the new dams located at the site of the colony the year following the high water. Because of changing irrigation requirements the flow of the Alamo River, whose banks are populated by Sonora beavers, is subject to frequent minor fluctuations throughout the year, while occasional heavy storms may put the stream out of its banks. Nevertheless, beavers are thriving on the lower reaches of this stream. Also, the flow of the Colorado River, along whose banks beavers once were abundant, was subject to extreme fluctuations prior to the construction of Boulder Dam.

Beavers appear to shun areas where certain impurities are present in the water. Roland G. Parvin (MS. 1939) is of the opinion that beavers in Colorado dislike water containing excess acid, sulphur or other chemicals. This may explain why New River is without beavers. It has a relatively high salt content as the water is mostly drainage from irrigated land. Also the pollution of New River by sewage from Mexicali, Calexico, El Centro, Imperial, Brawley and Westmorland may discourage beavers from living in the stream.

A second habitat requirement of beavers is an adequate food supply at the site of the colony. In general, the food preferences of the three races of native beavers and the introduced races are similar. Woody plants probably make up a large part of the beaver's food, in winter months at least, but tules and other non-woody plants are eaten (see table 1). Of the woody plants, trees of the genus *Populus* appear to be most sought after by both the native and introduced races of beavers in the State, while willows appear to rank next in order, and alders third.

TABLE 1

PLANTS CUT BY BEAVER

| | |
|--|---|
| <i>Pinus ponderosa</i> (Western Yellow Pine) | <i>Betula fontinalis</i> (Water Birch) |
| <i>Abies concolor</i> (White Fir) | <i>Corylus rostrata</i> (California Hazel) |
| <i>Abies magnifica</i> (Red Fir) | <i>Quercus garryana</i> (Oregon Oak) |
| <i>Juniperus occidentalis</i> (Sierra Juniper) | <i>Nymphaea polysepala</i> (Pond Lily) |
| <i>Typha latifolia</i> (Common Cattail) | <i>Pearus</i> sp. (Domestic Peach) |
| <i>Scirpus acutus</i> (Common Tule) | <i>Cercis occidentalis</i> (Red-bud) |
| <i>Lilium</i> sp. (Lily Family) | <i>Tamarix gallica</i> (French Tamarix or Salt Cedar) |
| <i>Salix</i> sp. (Willow) | <i>Cornus californica</i> (Creek Dogwood) |
| <i>Populus fremontii</i> (Fremont Cottonwood) | <i>Cephalanthus occidentalis</i> (Button-willow) |
| <i>Populus trichocarpa</i> (Black Cottonwood) | <i>Racchavis glutinosa</i> (Water Wally) |
| <i>Populus tremuloides</i> (Aspen) | <i>Pluchea sericea</i> (Arrowweed) |
| <i>Alnus rubra</i> (Red Alder) | <i>Artemisia tridentata</i> (Common Sagebrush) |
| <i>Alnus tenuifolia</i> (Mountain Alder) | |

Beavers occasionally cut other woody plants, but these apparently do not constitute an important source of food and may be used only for the construction of dams or lodges. Pine (*Pinus*), fir (*Abies*), juniper (*Juniperus*), oak (*Quercus*), California hazel (*Corylus*), dogwood (*Cornus*) and water birch (*Betula*) were among the other woody plants occasionally found cut by Shasta and non-native beavers in northern California and the Sierra Nevada. On Putah Creek, golden beavers had cut a few small twigs of red-bud (*Cercis occidentalis*)

growing adjacent to a colony, and on the Alamo and Colorado rivers water wally (*Baccharis glutinosa*), arrowweed (*Pluchea sericea*), and the exotic plant known locally as "salt cedar" (*Tamarix*) were occasionally found cut by Sonora beavers.

On Little River, in Humboldt County, the colony of introduced beavers appeared to be feeding almost exclusively on alders. The plant growth along this stream was predominantly of this species; cottonwoods and willows were absent where the beavers were situated. At other beaver colonies in northern California alders were seldom cut by beavers where willows, aspens or cottonwoods were present. Conditions at the Little River colony, which in 1940 appeared to be flourishing, suggest that although alders may not be preferred food, beavers will utilize them if nothing better is available. At most of the colonies of Shasta beavers in northern California, willow was the most abundant food plant and the one most used. However, where aspens or cottonwoods were present, they were as a rule taken in preference to willows. In Pine Creek Basin almost all of the available aspens had been cut by introduced beavers, while a thicket of willows growing there had hardly been touched by them. At least part of the willows cut by these beavers was used in the construction of dams. One dam at this colony contained also small amounts of beaver-cut sagebrush (*Artemisia*), but no evidence was found to indicate that this plant was used for food.

Because willows were the most abundant woody plant growing along the streams in the Great Valley, golden beavers appeared to be relying chiefly on them as a source of bark for food. Where present, cottonwoods were cut heavily, but the relative scarcity of this tree makes it generally unimportant as a food source for golden beavers. In addition to willows and cottonwoods, small amounts of other woody plants were found cut by the golden beaver, including domestic peach trees.

As with the golden beaver, the woody food supply of the Sonora beaver in southeastern California consists chiefly of willows. What cottonwood was present was cut heavily, but there, as in the Great Valley, its relative scarcity makes it unimportant as a food source in most places where the Sonora beaver lives. The animals' preference for cottonwoods was illustrated in many instances. For example, the flora of a fourth of an acre near Yuma consisted of about 93 per cent willows, 1 per cent *Tamarix*, and 5 per cent cottonwoods, along with small amounts of arrowweed, water wally and other plants. Of the 43 trees cut by beavers in this area, all of which were of about equal size, 41 were cottonwoods and 2 were willows.

When available, beavers utilize tules (*Scirpus* sp.) and other aquatic vegetation. Such plants, as suggested by Bradt (1938, p. 154), probably constitute a more important part of the beavers' diet than is generally supposed. Shasta beavers living on the lower part of the North Fork of Willow Creek and on Steele Swamp in Modoc County were cutting comparatively large amounts of tules when these places were visited in the summer of 1940, while indications were found that beavers on the Susan River in Lassen County were utilizing the roots and stems of pond lilies (*Nymphaea*) and other aquatic plants.

In the delta area, tules, supplemented by willow-bark, constituted the main diet of golden beavers, and in many parts of this area beavers were abundant where willows were relatively scarce. In such places tules were always abundant, and usually only moderate numbers of the willows growing at these locations had been cut by beavers, indicating that beavers inhabiting the delta prefer tules to willows.

The Sonora beavers also utilize large numbers of tules where this plant is available. In some areas, for example along the Colorado River about 7 miles north of Needles, in early May it appeared that tules constituted more than 50 per cent of the beavers' food. Here along 100 yards of low bank supporting a mixed growth of small willows, salt cedar (*Tamarix*), and tules, beavers had recently dug approximately 200 square feet of soil to gather tule roots, whereas, only 31 willow trees, 1½ inches in diameter, had been recently cut (fig. 14).

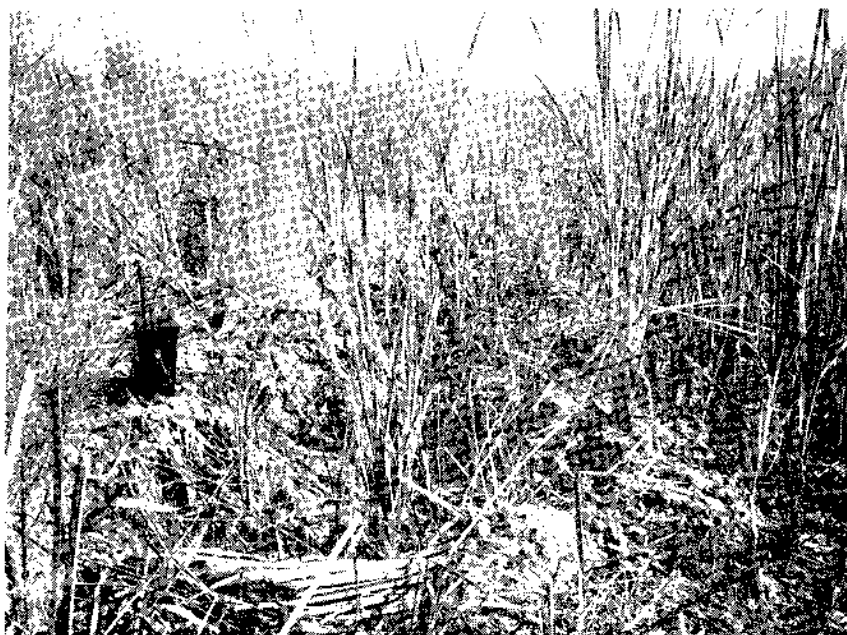


FIG. 14. Tule bed along Colorado River, 7 miles north of Needles, where beavers have dug for tule roots. May 1, 1940.

To be utilized by beavers, food must be so accessible as to permit the animals to take it without traveling far from deep water. When a supply of food is situated at a distance from deep water, beavers may dig canals leading to the supply, providing the intervening land is low-lying, level, and easily dug. Such canals were found in several places along the Colorado River and in the delta of west-central California.

According to Bradt (1938, p. 156), Michigan beavers may travel as far as 650 feet from water for food. In most places in California where beavers were found there was still an adequate supply of food available to the animals near at hand; therefore it was unneces-

sary for them to travel far. The greatest distance noted was along the Colorado River, where Sonora beavers had traveled 240 feet from the stream to fell a cottonwood. From the colony at Pine Creek Basin, in Modoc County, beavers traveled 225 feet uphill to cut aspen trees. In both of the places just mentioned, the supply of cottonwood or aspen adjacent to the colonies had been depleted, but willows were available.

Bradt (*loc. cit.*, p. 157) estimated that in Michigan one acre of aspens will support a colony of 5 beavers for from one to $2\frac{1}{2}$ years. This does not take into account any other vegetation eaten, which may be considerable. While there is, of course, a minimum amount of food on which a beaver can survive, my observations indicate that often the amount of food cut is in excess of this minimum. Where large aspens, cottonwoods or willows are abundant, beavers may utilize the bark



FIG. 15. Willow stumps standing in water more than 6 feet deep. Beavers cut most of the trees about 15 inches above the level of the water. Upper end of Lake Havasu, Colorado River. May 4, 1946.

from only the smaller limbs of felled trees, leaving that on the trunk and larger limbs. Where these trees are scarce, beavers may utilize the bark from the trunk as well as that from the large limbs. At the upper end of Lake Havasu, on the Colorado River, where the food supply had been almost exhausted, the beavers were chewing even the dead, almost dry bark of the trunks of willows that had been felled for some time. Also, beavers at the upper end of this lake had cut willows standing in water more than 6 feet deep (fig. 15). On Willow Creek, in Modoc County, beavers appeared to be utilizing all of the bark from the small willows cut by them; many twigs only $\frac{3}{8}$ inch in diameter had been completely stripped of their bark. By thus using

nearly all the food that they cut these beavers were successfully living where the supply of willows and other food was limited.

It has been noted that when beavers are introduced into an area they tend to cut trees far in excess of their needs and thus may in a few seasons exhaust a supply of food that should normally have lasted them much longer. This is especially true where aspens form the main food source. For example, on Dardanelle Creek in Tuolumne County, beavers had felled a large number of aspens, many of which subsequently were almost untouched. At the rate they were felling the aspens it appeared that in a few years the supply would be exhausted.

In addition to adequate supplies of food and permanent water, beavers require, at the site of a permanent colony, either mud for plastering dams or soil in which to dig bank-burrows. Only one beaver was found where soil was unavailable. It lived at the upper end of



FIG. 16. Beaver house built against a rocky wall beside the Colorado River in Mohave Canyon, 5 miles below Topock, Arizona. May 3, 1940.

Lake Havasu, in a stick-beaver house built against a steep, barren rock at the water's edge (fig. 16). Probably it was living there only temporarily.

It has often been said that California beavers, especially the golden and Sonora beavers, are "bank beavers," while the northern races are "house builders." It is the writer's opinion that, where feasible, all three races of beavers found in California normally prefer to live in bank-burrows rather than houses. This probably is true also of the races introduced from Idaho and Oregon, for whenever these animals were found near high banks of soil, the animals usually lived in burrows in the banks rather than in houses, although in each of the places concerned houses could have been built. Where banks of soil are absent

or are so low as to prevent the animals from digging a dry living chamber, houses are constructed. For example, in the marshy area at the head of the lake behind Imperial Dam on the Colorado River, banks of soil were absent, and all of the Sonora beavers appeared to be dwelling in houses which they had constructed.

Colonies of beavers often are situated close to dwellings of man, or to places frequented by him, but these usually are places where they are unmolested. Trappers in the delta have said that the trapping of one or more beavers in a colony usually causes the other members of the colony to move elsewhere. A number of other trappers have told me that they were of the opinion that the trapping of beavers from a colony tended to make the other members of the colony wary, and might even cause them to abandon the site. Nevertheless, Bradt (1938, p. 140) states that the beavers which he studied in Michigan were but little disturbed by live trapping and would often repair a dam a few feet from where one of their fellow members was held in a live trap. Because of their indifference to live traps, he is of the opinion that all members of a colony can be taken by placing the traps under water at a hole previously torn in the beavers' dam.

In a number of places, ranchers in California have found it difficult to cause beavers to abandon a colony by merely disturbing the dams. For example, at Steele Swamp in Modoc County, J. Stratton tried unsuccessfully to induce beavers to evacuate a colony by tearing out the dams that were interfering with his irrigation system. It was not until, on the advice of an old trapper, he placed broken pieces of window pane edgewise in the broken dam that they abandoned the place!

It is not known whether climate is a critical factor in limiting the distribution of the three races of beavers in California, but it has been generally assumed that the golden and Sonora beavers would not succeed should they be transplanted to northern California or to the Sierra Nevada, where the climate is relatively cold. In view of the beaver's ability to adapt itself when it is transplanted from one environment to another, it seems that the lowland forms might be able to survive if transplanted to higher elevations. If this is true, the absence of beavers on the western slope of the Sierra Nevada might be explained by the barrier that separates the mountains from the valley, where the golden beavers live. This barrier is a strip of foothill terrain some 25 miles wide where the streams flow through rocky canyons that are unsuited for beavers. To reach the montane meadows, beavers, in migrating from the lowlands, would have had to follow up these rocky stream beds from an altitude of a few hundred to around 5,000 feet. Possibly this was not an impassable barrier for beavers but they seem never to have crossed it.

THE PLANTED BEAVER COLONIES IN CALIFORNIA

Because of the beaver's value as a fur resource and as an aid in water conservation and control of soil erosion, conservation agencies have made efforts to extend the range and increase the size of the present California population by transplanting live animals to selected places not now inhabited by them. The first transplanting of beavers in

California was done near Taylorsville, in Plumas County, in 1923, by Will E. Stanford. The next transplanting was done by the U. S. Forest Service in late August of 1934, when 4 beavers from Idaho were introduced into Rowland Creek in Plumas County. Since that time other transplantings have been made by the U. S. Forest Service and by the California Division of Fish and Game. By September of 1940, both agencies had transplanted a total of 95 beavers into 14 colonies in central and northern California (fig. 2, p. 8). Because of the generally wise policy of wildlife management of these two agencies, California has been more fortunate than some states in that, save for one instance (see below under Little River Colony), no exotic beavers have been introduced into the known ranges of our native races. Thus, native beavers have been spared the racial pollution that follows the mixing of different subspecies. The view of biologists is that the transplanting of non-native stock into an area inhabited by native stock is undesirable. The principal reasons for this view may be summarized as follows:

1. It seems logical that native animals are more likely to thrive than are nonnative animals, because, over a period of many centuries, native animals have become adapted to the environmental conditions present within their range.
2. If nonnative animals introduced into the range of a native race do thrive, they would probably do so at the expense of the native stock.
3. Subsequent breeding between the native stock and the introduced animals might cause their extinction through racial dilution. At best, a race of mongrels would result.
4. The mixing of stock may result in the introduction of diseases; parasites to which the native stock is not adapted may cause it to die out or to become unhealthy.
5. For purely esthetic reasons it is deemed undesirable to pollute the racial purity of native wild animals. It is a satisfaction to the public, as well as to biologists, to know that when they see an animal or the sign of an animal, it is, or was made by, the same kind of animal that occurred naturally in the area.

The one place in California where out-of-State beavers were transplanted to a range thought to have been formerly inhabited by native stock is Little River in Humboldt County. Oregon beavers were transplanted into what was probably the former range of a native race, thought to be *shastensis*.

The following descriptions are of the known beaver colonies transplanted by the U. S. Forest Service and the California Division of Fish and Game from the summer of 1934 to September, 1940. No transplantings are known to have been made by these agencies before 1934.

Little River Colony: On October 29, 1939, 5 beavers from Bridge Creek, Wheeler County, Oregon, forming a part of the Oregon exhibit at the Golden Gate International Exhibition at San Francisco in 1939, were turned over to the California Division of Fish and Game. The animals were liberated on the same day on Little River at an elevation of about 300 feet, 5 miles east and 1 mile north of Crannell, in Humboldt County, California. Little River, at and below the planting site, carried an estimated 30 second-feet of water on November 12, 1940, when the

writer visited the colony. Alder (*Alnus*) made up more than 90 per cent of the vegetation along the banks, and it was on this, together with a limited amount of aquatic vegetation, that the five animals appeared to have been feeding. The beavers in this colony had moved downstream from the place where originally planted and had cut alder trees as far as $\frac{1}{2}$ mile below Crannell. Most of the cutting of alder had been done at a point about 2 miles above Crannell and around an old mill pond immediately above Crannell where more than 50 alders, whose trunks were more than 3 inches in diameter, had been cut. Elsewhere only scattered trees had been felled.

No data as to the sex of these beavers were kept by the Division, and no indication was found that young had been born to the transplanted animals. Judging from the way in which the animals apparently have established themselves, it appears probable that the plant will prove successful, unless, of course, all of the animals are of the same sex. It is recommended that these beavers be removed and animals of the native race *shastensis* substituted in their place.

Scott Valley Colony: On September 22, 1936, 1 male and 3 female Shasta beavers, which had been trapped by the U. S. Forest Service in Modoc County and turned over to the California Division of Fish and Game, were planted on Marlahan Slough, 5 miles south and 1 mile west of Fort Jones in Siskiyou County. According to J. R. DeCamp of the Modoc National Forest, these beavers were kits that had been caught along with their parents and yearling siblings. The older animals were kept by the Forest Service and transplanted to localities in Modoc County. Marlahan Slough parallels the Scott River and carries a small, permanent, sluggish flow of water. Many willows mixed with choke cherry (*Prunus*), California blackberry (*Rubus*) and other woody plants grow along its banks of deep soil.

The beavers were released on the Jenner Ranch, 6 miles south and 1 mile west of Fort Jones, at an elevation of about 2,800 feet, but in the spring of 1937 they moved downstream $1\frac{1}{2}$ miles onto the ranch of C. W. Holmes. Since that time they have increased to an estimated 13 animals in three poorly defined colonies along a mile of the slough about 4 miles south and 1 mile west of Fort Jones. On August 30, 1940, 2 adults and 1 young beaver from Modoc County were added to the upper colony on Marlahan Slough. Thus, the total population of the three colonies was 16 in September of 1940.

A series of dams at the site of each colony had formed deep pools. The dam most recently constructed was 18 feet long and 18 inches high and had been started at the upper colony about 2 weeks prior to my visit to it, according to C. W. Holmes. Three stick houses were found, all at the middle colony. The largest house was 18 feet long, 12 feet wide and 6 feet high. The entrance to what I took to be a burrow in the bank was seen at the lower colony. Although some freshly cut sticks were used in the construction of the dams and houses, these structures were for the most part built of broken pieces of drift wood, and dead willow sticks gathered by the beavers beneath the dense willow thickets; most of these dead sticks were uncut by beavers.

Shields Creek Colony: On August 28, 1940, 1 adult and 1 young Shasta beaver trapped on lower Lassen Creek by Warden Don Davison of the California Division of Fish and Game were transplanted by him to the headwaters of Shields Creek at an elevation of about 6,400 feet in the southeast corner of Section 1, Township 41 north, Range 14 east, Mount Diablo Base and Meridian, in the Warner Mountains of Modoc County. This planting site was not visited by the writer. Mr. Davison is of the opinion that it is a good one for beavers. The sex of the animals was not ascertained, and it is possible that both are of the same sex. Also the fact that one of the animals was a kit and therefore more liable to destruction, reduces the chances that the planting will be successful.

Pine Creek Colony: On September 14, 1936, 1 pair of adult and 1 pair of subadult Shasta beavers trapped on lower Davis Creek in Modoc County were transplanted by the U. S. Forest Service to Pine Creek Basin at an elevation of about 6,700 feet on the western slope of the Warner Mountains, 7 miles west and 4 miles north of Eagleville, in Modoc County. The beavers were planted in the marshy, lower end of the basin on one of a group of sedge-bordered ponds around which grew a dense stand of aspen. Immediately above the ponds there were numerous willow thickets along Pine Creek, which at the lower end of the basin meanders through the meadow. Several sloughs are connected with the creek. District Ranger A. E. Noren of the Modoc National Forest, who aided in the planting

of the beavers in this colony, visited it occasionally after their introduction and noted the progress that they had made in establishing themselves. According to him, 6 weeks after their transplanting they had cut more than 100 aspens whose trunks ranged from 2 to 18 inches in diameter, as well as many smaller trees. They had also built a dam 12 feet long and $3\frac{1}{2}$ feet high across the lower end of one of the natural ponds in which they were planted, and in a clump of willows near the middle of the pond had built a house which he estimated to be 8 feet in diameter and 6 feet high. Following their establishment at the planting site, some of the animals crossed overland to a point about 100 yards away and built a large dam across Pine Creek that flooded 5 or 6 acres of meadow. On visiting the colony in 1940, the writer found that most of the aspens growing within 100 feet of the ponds had been felled by beavers (fig. 17). Having depleted the aspen grove adjacent to the ponds, the animals had cut a few of the willows above the ponds, but for the most part appeared to be feeding on aspens growing farther back from the water's edge. A group of 6 dams had been constructed between, and across the lower ends of, the ponds. The largest dam was 100 feet long and 4 feet high and was built of



FIG. 17. Aspen grove in Pine Creek Basin, Modoc County, heavily cut by an introduced colony of beavers. September 6, 1940.

cut aspen sticks laid vertically along the face of the dam. Only a little mud was used in its construction, but the smaller dams were well plastered with mud. One large house, about 12 feet in diameter and $4\frac{1}{2}$ feet high, stood in the original pond where the beavers were planted; apparently this was the same house that Noren observed in 1936 (fig. 18). It appears that this colony has reached its peak of development, and that, unless the animals begin feeding more extensively on the available willows, their supply of aspen will soon become exhausted. If they refuse to utilize the willows, it appears that they probably will be forced to abandon the site within a few years. Judging from the amount of recent activity, and from the fact that there was only one house, I think that no more than 4 animals were present in 1940. Sign of 1 beaver, found in 1940 on Clear Lake, in the Mill Creek drainage, 6 miles south and 1 mile west of Pine Creek Basin, may have been that of an animal that left the planted colony.

Bear Creek Colony: On September 17, 1936, 5 Shasta beavers, consisting of 2 pairs of adults and 1 young female, were trapped on the lower part of Willow Creek (near Willow Ranch Post Office), in Modoc County, by the U. S. Forest Service, and transplanted to Bear Creek in Section 33, Township 39 north, Range 16 east,

Mount Diablo Base and Meridian, in the Warner Mountains of Modoc County. At the planting site, Bear Creek flowed through a wide, flat-bottomed canyon. Along the banks of the creek were clumps of small willows scattered among the sagebrush that covered the bottom of the canyon to the water's edge. A considerable amount of broken rock was mixed with the soil that formed the banks of the creek. When the colony was planted, a dam and a house were constructed for the use of the animals, but according to Noren, who watched the fortunes of this plant, as well as those in Pine Creek Basin and on East Creek, the beavers did not utilize the man-made accommodations and within a few days disappeared. In the spring of 1937 Noren found fresh cuttings on aspens on Emerson Creek, about 3 miles north of Bear Creek. He is of the opinion that the animals that lived on Emerson Creek migrated there from Bear Creek, even though this would have meant a trek overland across a ridge. No additional fresh cuttings have been found. When I examined the planting site in 1940 there was no sign of old or new beaver cuttings, but the remains of the man-made dam were still apparent (fig. 19). Old cuttings on aspen, willow,



FIG. 18. Pine Creek Basin, in the Warner Mountains of Modoc County, where a colony of Shasta beavers was introduced in 1936. Note beaver house near left center of picture. September 5, 1940.

cottonwood and on water birch (*Betula*) trees were found on Emerson Creek at the mouth of Cole Creek, however.

East Creek Colony: On September 5, 1936, the U. S. Forest Service released 6 Shasta beavers on privately owned land on the South Fork of East Creek in Section 9, Township 38 north, Range 16 east, Mount Diablo Base and Meridian, in the Warner Mountains of Lassen County. These animals, consisting of 1 pair of adults, 1 pair of yearlings and two male kits, were taken from Lassen Creek in Modoc County. The South Fork of East Creek, at the planting site, meanders through a flat-bottomed, shallow canyon. Scattered, thin clumps of small willows, mostly less than 5 feet high, border the 3-foot soil banks. Sage, interspersed with scattered clumps of aspens, grows about 30 yards back from the stream on the lower part of the low hillsides.

Employees of the Forest Service constructed a small dam and a house for the animals, but it is not known whether these were used. According to Noren, these animals did not remain long at the planting site but moved downstream 2 miles into Modoc County. Noren thinks that they spent the winter there, for he found where

they had done considerable cutting on aspens. No further sign of the colony has been found, except that in the fall of 1937 the carcass of one animal was located about 1 mile below the point where they supposedly wintered. On inspecting the planting site in 1940, the writer was unable to locate any beaver sign, either old or new, but old cuttings on aspens were found at the point where Noren said the animals wintered.

*Indian Creek beaver farm.*⁴ The first transplanting of beavers in California was done in 1923, when Will E. Stanford trapped and moved a group of live Sonora beavers from the Colorado River to Indian Creek, about 5 miles above Taylorsville in Plumas County, for the purpose of starting a beaver farm. Between January 1 and February 20 of that year Stanford trapped 66 beavers along the river with number 4 steel traps, but because many of the animals were injured in trapping and handling, only part of them were successfully transplanted. It is not known how many live animals were moved, but on September 3, 1923, Stanford had 23 live animals on his farm.



FIG. 19. Site of a beaver transplanting that apparently failed. Note remains of man-made dam, built to form an artificial pond for the introduced beavers. Willow growth was small and sparse at this location. Bear Creek, Modoc County. August 29, 1940.

The animals were temporarily held in a one-third acre enclosure surrounding a natural pool 100 feet long, 30 feet wide and 4 feet deep. Later they were placed in a larger and permanent "beaver-proof" fenced enclosure. The beavers were fed willows, which were cut by Stanford and thrown along the bank of the pond; dry alfalfa hay and carrots supplemented their diet. The animals were also fond of bread. Feeding was done each afternoon about 5 o'clock.

By September 17, 1924, Stanford had moved a total of 61 beavers into the permanent enclosure. Eleven of these animals were golden beavers from the San Joaquin River near Mendota. The introduction of the golden and Sonora beavers into the same enclosure did not prove successful, however, for the animals fought one another with the result that 10 of their number were killed. This, and other observations made by Stanford, led him to believe that two kinds of beavers are not likely to fight if put together in small enclosures on land, but if put into large

⁴ Most of the data regarding this beaver farm were taken from the field notes of Joseph S. Dixon, who visited the farm in 1923 and 1924.

enclosures where there is water they will fight one another. On the other hand, muskrats from Honey Lake, which were kept in the same enclosure, lived in complete harmony with the beavers; Stanford frequently would see a grown beaver and a muskrat lying asleep side by side when he looked into the boxes provided for them.

Although these beavers were moved from an area where the winters are mild to one where the winters are relatively severe, they appeared to stand the change satisfactorily, even though in the winter of 1923-24 the water froze to a thickness of 8 inches on the beaver ponds and the snow reached a maximum depth of 14 inches on the ground.

This beaver farm ceased operations when Stanford died a few years after it was established. The accounts of what happened to the beavers vary. One account is that the beavers were pelted and sold by Mrs. Stanford; another is that high water washed out a part of the fence allowing the beavers to escape, and another is that the animals were released by one of the parties having an interest in the farm. In any case, the statements of a number of persons who lived along Indian Creek



FIG. 20. Site of a successful transplant of beavers. Rowland Creek Canyon, Plumas County. Note dense aspen growth in canyon bottom. August 19, 1940.

when the farm was in operation indicate that at least some of the beavers escaped or were liberated. It is possible that the colony now present farther down on Indian Creek near Crescent Mills came from stock that was liberated or escaped from this farm.

Rowland Creek Colony: In late August of 1934, 2 pairs of Snake River beavers (*Castor canadensis taylori*) from Bingham County, Idaho, were released by the United States Forest Service on Rowland Creek at an elevation of 6,200 feet, 3 miles west and 1 mile south of Meadow View Ranger Station, in Plumas County. Because it was learned that one of the planted females had died, another female plus an additional pair of the same subspecies from Blaine County, Idaho, were added to this colony in early November of 1934. Rowland Creek, arising as a spring, carries a small but permanent flow of water. Two miles of its course is through a flat-bottomed canyon about 75 yards wide, covered with a dense growth of aspens (fig. 20). The trunks of the aspens mostly are less than 5 inches in diameter. The dense growth of small aspens is accounted for by the fact that the entire grove was destroyed by a fire in 1926. Immediately below the aspen grove the stream flows through a group of willow thickets, after which it enters an open plain.

According to District Ranger B. Beard of the U. S. Forest Service, who has watched carefully the development of this colony, the beavers were planted in a thicket of aspens about $1\frac{1}{2}$ miles from the headwaters of the stream. Two log dams were built by Forest Service employees to form artificial ponds before the animals were released. One of these dams was used by the beavers. The next year (1935) this dam was enlarged by the animals, and 2 or 3 smaller dams were built nearby. In the autumn of 1935 one young was seen. By the autumn of 1936 the beavers had built several more dams and had cut aspens and willows up and down stream for a mile each way. In the Spring of 1937 the animals built 2 dams across the creek in the willow thickets at its lower end; water from these dams spread over $1\frac{1}{2}$ acres of meadow. In the Autumn of 1937, Beard found 3 dams about $\frac{1}{2}$ mile above the original planting-site, and in 1938 he found 3 beaver houses made of sticks. In 1939 the colony continued to thrive, and in 1940 when it was visited by the writer there was a total of 25 dams along a $1\frac{1}{2}$ -mile stretch of creek, but no dams or other sign of beaver activity were found among the willows. The dams were in two



FIG. 21. Downstream side of large beaver dam on Rowland Creek, Plumas County. August 13, 1940.

groups about $\frac{1}{2}$ mile apart; the upper group contained 14 dams, 9 of which were more than 50 feet long. Out of the total number of 25 dams on Rowland Creek, 6 were more than 200 feet long, the largest being 270 feet long and 6 feet high (figs. 21 and 22). Four beaver houses were found in the upper colony, and 3 in the lower. From the amount of fresh work, it was judged that no less than 12 beavers were in the upper colony while 10 were in the lower. These animals appeared to be living almost entirely on aspens. Even though the animals apparently have been exceptionally active, there was no indication that the supply of aspens was being exhausted. New growth was sprouting from the stumps of the trees cut.

In 1936 Beard found fresh beaver cuttings on Ramelli Creek, $2\frac{1}{2}$ miles overland, or 12 miles by stream, from Rowland Creek. Beavers worked on Ramelli Creek until 1939, after which no more fresh sign was seen. Presumably these animals migrated from the Rowland Creek Colony. In 1938, fresh beaver work found on Little Last Chance Creek at points 2 and 8 miles below Ramelli Creek, and on

Thompson Creek, may have been made by migrants from Rowland Creek. In 1939 no fresh work was found at these places, according to Ranger Beard.

Meiss Meadow Colony: Two pairs of beavers from Section 23, Township 20 south, Range 3 east, in the Rogue River National Forest of Oregon were transplanted to Meiss' Meadow, at an elevation of about 8,200 feet, in the El Dorado National Forest, El Dorado County, California, by the U. S. Forest Service on August 27, 1938. The Upper Truckee River, which flows slowly through a meandering channel that it has cut in the floor of this meadow, was about 10 feet wide and in places 3 feet deep in the summer of 1940. Scattered thickets of small willows bordered the stream, and in the lower end of the meadow there were also a few aspens and alders. The beavers were planted at a deep pool in a thicket of willows near the middle of the meadow, where the Forest Service had built a house, 4 feet square, for them. According to District Ranger M. D. Morris the beavers did not stay in the house. Instead they built and occupied a house of sticks on land about 5 feet from the pool, and connected to it by a tunnel. These beavers built 10 dams



FIG. 22. Looking along the top of the dam shown in Figure 21. August 19, 1940.

that were too small to make any appreciable change in the level of the water. In June of 1939 fresh cuttings were found several miles downstream from the meadow, and an examination of the planting site revealed that the beavers had abandoned the place. In July, 1940, the author examined the place where the beavers were released and found many old cuttings on willows between there and the lower end of the meadow. Two dams, one of which was old and broken, 2 old bank burrows, one of which had collapsed, and a trench, 75 feet long, 2 feet deep, and from 1 to 4 feet wide leading into the willows, were found at the lower end of the meadow. Several aspens had been cut at heights of up to 9 feet from the ground, indicating that the animals had been forced to forage for food on top of the snow in the winter. A small amount of freshly cut willows found among the old cuttings and a freshly used slide beside the intact bank burrow at the lower end of the meadow indicated that 1 animal was still living there in 1940. Below Meiss Meadow the stream in general drops rapidly, but at intervals flows through relatively flat, meadowlike areas. Here the water is deep and flows slowly through soil-banked channels, which are bordered by dense growths of aspens, alders and willows. A bank burrow and a group of fresh alder cuttings were found at a deep pool in one of these level areas 2 miles below the place where the animals were released. This was made by what I judged to be 1 animal. At a point 2 miles farther downstream a newly built dam,

a bank burrow and about 40 freshly cut aspen, alder and willow trees marked what I took to be the home site of 2 more beavers. In general, it appears that the Meiss Meadow planting has not been entirely successful, for although the animals are apparently holding their own, they so far have seemingly failed to establish themselves permanently in any one place.

Wheats Meadow Colony: In mid-September of 1934, 2 pairs of Snake River beavers (*Castor canadensis taylori*) from Blaine County, Idaho, were released behind a man-made dam on Wheats Meadow in the Stanislaus National Forest, at an elevation of 6,600 feet in Tuolumne County, California, by the U. S. Forest



FIG. 23. Aspen trunk, 13 inches in diameter, cut by beaver. Wheats Meadow, Tuolumne County. August 12, 1940.

Service. Wheats Creek, which has cut a meandering channel 2 to 6 feet deep in the soil of the meadow, is of such small size that the surface flow disappears along parts of its course in the summer. Willows, aspens and alders grow along its banks.

The animals were released behind a dam, previously constructed by the Forest Service, about 300 yards below the Brightman Ranger Station. District Ranger J. T. Kenney visited the place of release on July 17, 1935, and found that the beavers had moved upstream about a half mile where they had constructed several dams. In 1936 he again visited Wheats Creek and other streams

in the vicinity. He found that, although beavers were still working in Wheats Creek, some of them had moved about $1\frac{1}{2}$ miles south to Dome Rock Creek, where they had constructed several dams and done considerable cutting on aspens, willows and alders. On August 22, 1938, Kenney, with Fred Johnson of the Division of Wildlife Management in the Regional Forest Service office, and Forest Supervisor J. R. Hall, walked along the streams in the Wheats Meadow area for 2 days and found that the only active colony was that on Wheats Creek; the Dome Rock Creek colony had been vacated. In 1939 Kenney found fresh cuttings on aspens along a half-mile stretch of Highland Creek, immediately below Gabbot Meadow, about 6 miles northeast of Wheats Meadow. In that year Kenney received word that Mr. Cozart of the Pickering Lumber Corporation had seen fresh beaver cuttings at the main trail-crossing on Shuffy Creek.

When the writer visited Wheats Meadow and vicinity in August of 1940 he found that the colony described by Kenney had been vacated. The site was marked by a large number of felled aspens, 14 of which had trunks of from 12 to 18 inches in diameter, and several collapsed bank burrows; only a few small trees were left standing in what apparently once had been a beautiful grove. One aspen whose trunk was 13 inches in diameter had been partially cut in three places, one above the other, before the fourth cut, 5 feet from the ground, resulted in its fall (fig. 23). A group of fresh cuttings on aspens and willows, 2 new dams, several fresh slides and a bank burrow were found at the lower end of the meadow about $\frac{1}{2}$ mile below the ranger station, while about $\frac{1}{4}$ mile farther downstream additional fresh sign was located. It was estimated that a total of 4 beavers were living at these two sites.

The colonies reported on Shuffy Creek and on Highland Creek immediately below Gabbot Meadows were not examined, but old cuttings were found on Highland Creek at the upper end of Spicer Reservoir (about 4 miles below Gabbot Meadows), and on Dome Rock Creek. These cuttings, as well as those found by Kenney, probably were made by migrants from Wheats Meadow. On one of his visits to the colony at Wheats Meadow, Kenney found the skeleton of a beaver.

Dardanelle Creek Colony: Because it was thought that the Wheats Meadow planting was doomed to failure, the U. S. Forest Service introduced 2 pairs of beavers from Crooked River in Oregon into Dardanelle Creek, at an elevation of about 6,700 feet, in Tuolumne County on August 27, 1938. The pairs were released about $\frac{1}{2}$ mile apart at a point about 2 miles southeast of the Wheats Meadow planting site. According to Kenney, who supervised the planting, a box 4 feet square was set in the earth bank of the stream and a dam built to form a pool deep enough to partially cover it at each planting site before the beavers were released. After its release each pair cut the dam provided for it, but one pair utilized its box; the other pair promptly abandoned its box. Kenney found that the beavers at each planting site had done considerable cutting on aspen, alder and willow trees later in the fall of 1938, and more in 1939. No dams were found.

In August, 1940, the writer and Seymour found beaver cuttings scattered for 2 miles along the stream, although they were most plentiful at and above the site where the lower of the 2 pairs was released. There, along 1 mile of the creek, more than 200 felled aspen trees were found, approximately half of which had trunks of more than 6 inches in diameter; 26 of these had trunk-diameters of more than 12 inches. Some cutting was found on willows, and 51 fir trees (*Abies*) had been either felled, or partly girdled, presumably by beavers (fig. 24). Many of the felled aspens had only a few of the limbs trimmed from them, indicating that the animals cut much more food than they were able to care for properly. Some of the trees had been cut as far as 5 feet from the ground, suggesting that the animals had worked on the surface of the snow. Four dams, the largest of which was 10 feet long and $3\frac{1}{2}$ feet high, were found in a $1\frac{1}{2}$ acre aspen grove where the lower pair of beavers was planted. No evidence was found to indicate that there were two separate colonies as originally planted, the two having apparently merged. Only one of the square boxes in which the animals were released was found, and it appeared to have been long abandoned by the beavers.

Judging from the extent of the fresh workings, it appeared that there were at least 6 animals living on Dardanelle Creek in 1940. This colony appears to have become established. The beavers have been cutting more aspens than they appear actually to need for food and this may unfavorably affect their fortunes in the future.

Pillsbury Lake Colony: On July 27, 1940, 6 golden beavers from the delta area were released by the California Division of Fish and Game on Rice Creek, 8 miles southeast of Hullville, in Lake County. On August 25, 1940, 3 additional golden beavers from the Merced River near Snelling in Merced County, were liberated there. Because of the recency of the planting, it is not yet known whether it will be successful. When the second introduction was made a young animal from the group previously transplanted was found dead.

Ragg and Putah Creek colonies: In the late Summer of 1938, 22 golden beavers were released by the California Division of Fish and Game on Ragg Creek immediately above, and at, its confluence with Putah Creek, at an elevation of about 300 feet, about $4\frac{1}{2}$ miles southeast of Monticello, in Napa County. Ragg Creek in July of 1940 carried about one-half of a second-foot of water. The 10-foot-high earth banks of the creek were steep and overgrown with willows, cottonwoods, elderberries, wild grapes and California blackberries. Putah Creek, which is bordered by a similar growth, carried a volume of water estimated at 25 second-feet in July of 1940.



FIG. 24. Fir trees cut by beavers, Dardanelle Creek, Tuolumne County. August 15, 1940.

According to J. R. Sidwell, who lives on the ranch where the beavers were planted, the animals had by 1939 built dams on Ragg Creek as far as $1\frac{1}{2}$ miles upstream from the planting site. They also had built a dam on Putah Creek $1\frac{1}{2}$ miles below Monticello, and across Putah Creek about $\frac{1}{2}$ mile above the mouth of Ragg Creek. High water in the Winter of 1939-1940 reached a depth of 6 feet in Ragg Creek and more than 30 feet in Putah Creek, according to Sidwell; ranch buildings situated at what I judged to be close to 30 feet above the creek bed had stood in more than 1 foot of water, as shown by the water marks around their bases. This high water destroyed the dams on Putah Creek and most of those on Ragg Creek.

When the planting site was visited on July 31, 1940, the author found that the animals reported as being $1\frac{1}{2}$ miles above the mouth of Ragg Creek in 1939 were no longer there, but that about 6 beavers were living on the stream about $\frac{1}{2}$ mile above its confluence with Putah Creek. These animals had built 3 dams, the largest of which was 30 feet long and $2\frac{1}{2}$ feet high. This dam was built of willow

and elderberry sticks, and drift lumber, and was weighted on top with rocks. The dam had backed water upstream for 150 yards into a pool that was 6 feet deep in places. Numerous fresh beaver cuttings and slides were found in the vicinity of the dams, but no stick houses were found; presumably the animals were living in bank burrows.

On Putah Creek there were 5 dams within the first mile above Ragg Creek; one of these dams, the construction of which apparently had been begun only recently, was unfinished (fig. 25). According to Mr. Sidwell, this dam was being built where a large destroyed dam had been situated in 1939. Judging from the amount of recent activity, it appeared that 8 beavers lived on this part of Putah Creek in 1940. About 1 mile further upstream a group of fresh cuttings around several deep pools suggested the presence of 3 animals. About 2 miles below Monticello a colony of 4 beavers was found. These animals had built a dam 30 feet long and more than 4 feet high. At one end it was anchored to a piece of wire hog-fencing that had been strung across the creek to hold livestock. The dam was constructed of willow and cottonwood limbs, mixed with axe-cut pear tree trimmings that apparently had been dumped into the creek bottom by

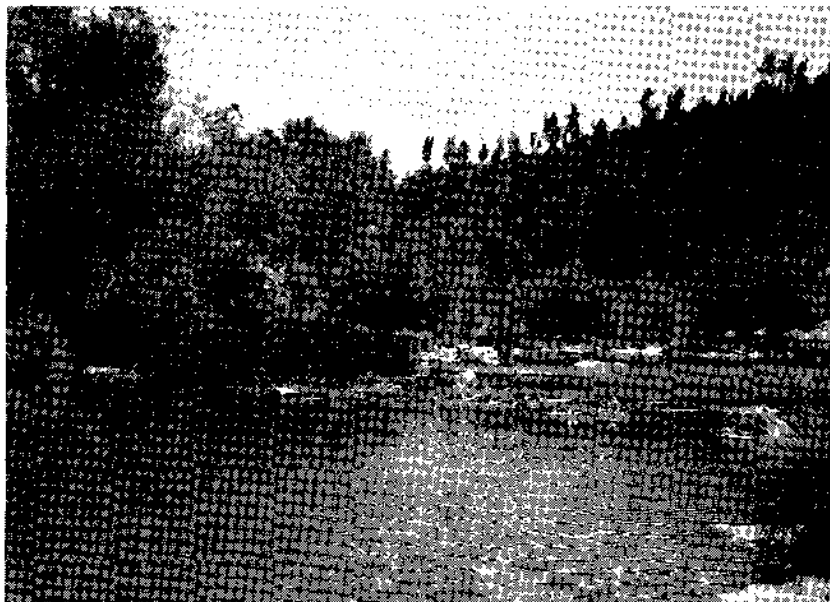


FIG. 25. A partially completed beaver dam at the site where a large dam was located prior to its destruction by high water in the winter of 1939-40. Putah Creek, Napa County. July 31, 1940.

ranchers. About 2 miles below the mouth of Ragg Creek 5 beavers had been cutting on willow and cottonwood trees; also, one small red-bud (*Cercis occidentalis*) had been cut by these animals. No dams were found at this colony.

In 1938, 9 additional golden beavers were released on Putah Creek about 7 miles above Monticello. Scattered fresh cuttings on willows were found along this part of the stream in 1940, but no indication was found that the beavers had become permanently established. It was assumed that the original 9 animals were present there in 1940.

Littlejohns Creek Colony: In 1938 Leland Drais of the California Highway Patrol, under the supervision of the California Division of Fish and Game planted a total of 7 golden beavers on Littlejohns and Rock creeks, about 3 miles above the junction of these streams, or about 6 miles above Farmington, in Stanislaus County. Each planting site was at an elevation of about 140 feet. According to Drais the beavers planted on Rock Creek abandoned that stream and apparently crossed to Littlejohns Creek, which carried a larger flow of water. In 1939 Drais saw 6

young beavers on Littlejohns Creek near where the animals were released. An examination of this stream in 1940 revealed fresh sign of 10 animals at scattered places for 3 miles upstream from a point 1 mile above Eugene.

Additional Colonies: Since writing the above, it has been learned that, in 1939 or 1940, golden beavers were introduced into Spring Valley Lakes, San Mateo County, San Pablo Reservoir, Contra Costa County, and Golden Gate Park, San Francisco County. The sites of these introductions were not visited and the fate of the animals released there is unknown.

FUTURE OF BEAVERS IN CALIFORNIA

Native beavers at present exist in limited numbers over most of their former known range. With proper protection and management it should be possible to increase the population in these areas to a point where a limited number of pelts could be taken annually. Even with proper management it is doubtful, however, that the number of beavers can ever be increased to a point comparable with that which existed before the State was settled by white men. Any successful management plan would of necessity involve adequate protection of the animals and some type of compensation for private landowners on whose holdings the colonies were located to offset the inconvenience that the animals frequently cause. This compensation could probably best be provided by allowing the landowner or his agent to harvest pelts. In northern California many of the suitable beaver habitats are on private lands, and in the Great Valley all of them are, so that unless the landowners are allowed to reap some benefits from the presence of the animals to offset the harm that they may do, it is unlikely that the beaver population there will ever increase much. Increase is especially unlikely in Modoc County, where most of the beaver habitats adjoin farmed lands.

In central California there is room for a considerable expansion of the beaver population along the main rivers, although here again the beaver's role in the economics of agriculture might make a large population undesirable in some places. With a few exceptions, however, beavers in the valley streams do not seriously interfere with agricultural enterprises. This is because most of the irrigated farm lands are not immediately adjacent to the streams. Water for irrigating such lands as a rule is taken from the streams at points far above the ranches, and the ditches usually are unsuited for beavers.

There is sufficient suitable habitat in the delta area to support a considerably larger population of beavers than lives there now. However, because of the potential damage that beavers may do to the levees, it probably would be undesirable to allow them to increase there to a point far beyond their present numbers.

In southeastern California the greatest potential beaver range is along the Colorado River. This stream affords suitable habitats for several times the number of animals that now live along its banks. Also, beavers living there would, in general, not interfere with agriculture. It appears that it would be undesirable to allow the beaver population to increase materially in the Imperial Valley, because most of that area is intensively farmed.

The meadows and streams in the Sierra Nevada, where native beavers were never known to occur, probably comprise the most extensive habitat for beavers in the State. Although the area of habitat suitable for beavers in the Sierra Nevada is undoubtedly less than in

the mountains of some other states, there are nevertheless many areas where beavers probably could establish themselves successfully. This is especially true in the northern part of the Sierra, where meadows and streams supporting aspens and willows are more numerous than in the southern part of the mountain range. Beavers living in the Sierra Nevada would usually not interfere with agriculture, because most of the suitable habitats are in National Forests. With proper management it may be a relatively easy matter to increase the population of beavers in the Sierra Nevada to a point where the animals would furnish a substantial income through the sale of fur, and also would aid materially in the control of erosion and rapid run-off.

The Coast Range north of San Francisco Bay also has beaver habitats, but because most of the streams there tend to be exceedingly steep and rocky, and meadows are relatively few, the number of such habitats is few. The Coast Range south of the Golden Gate is similar to that to the north as regards topography, but the more arid climate and the seasonal nature of the streams would seem to make this range of mountains generally unsuited for beavers.

RECOMMENDATIONS

In formulating a policy for dealing with the beavers of California, and in putting into effect a management plan for these animals, decision must be made on several points. Upon some of them a satisfactory amount of first-hand evidence has been accumulated. On other points the evidence is regrettably meager. The views formulated on the basis of this evidence and on information otherwise obtained have changed from time to time in the past and in expressing certain of them here I reserve the right of change in the future. As I now see it, when a policy for dealing with the beavers of California is formulated and when a management plan is put into effect, the following aims should be kept in view:

Aims

1. On a long-time basis so handle the beavers that they will yield a maximum return for the citizenry at large.
2. Take pains to preserve pure racial stock of each of the three kinds of California beavers in its native range because of the future potential, and now even unthought of, values that are inherent in any kind of native wild vertebrate animal.
3. Provide for harvesting a crop of fur by private trappers and provide for distributing on private and public lands the benefits to be indirectly obtained from the presence of beavers as comprised in their lessening of rapid run-off in streams and their promotion of a growth of beneficial plants and animals in the ponds and meadows.

Practices to be Avoided

1. Do not introduce one kind of beaver into the range occupied by another native kind.
2. Do not introduce a kind of beaver into an area adjacent to that occupied by a different native kind if there is any reasonable possibility of the two kinds ultimately meeting.

3. With Shasta beavers and golden beavers now occupying so small a fraction of their original ranges, special care should be exercised to use only methods and means of trapping and handling which will injure a minimum number of the animals and thus allow the maximum number to be transplanted.

4. Avoid any system of removing beavers from an area where they are a nuisance that will prejudice persons against beavers in instances where the animals are neutral or beneficial to man's interests.

Suggested Procedure

1. Reestablish each of the three races of native beavers over as much of their former ranges as is deemed desirable for man's best

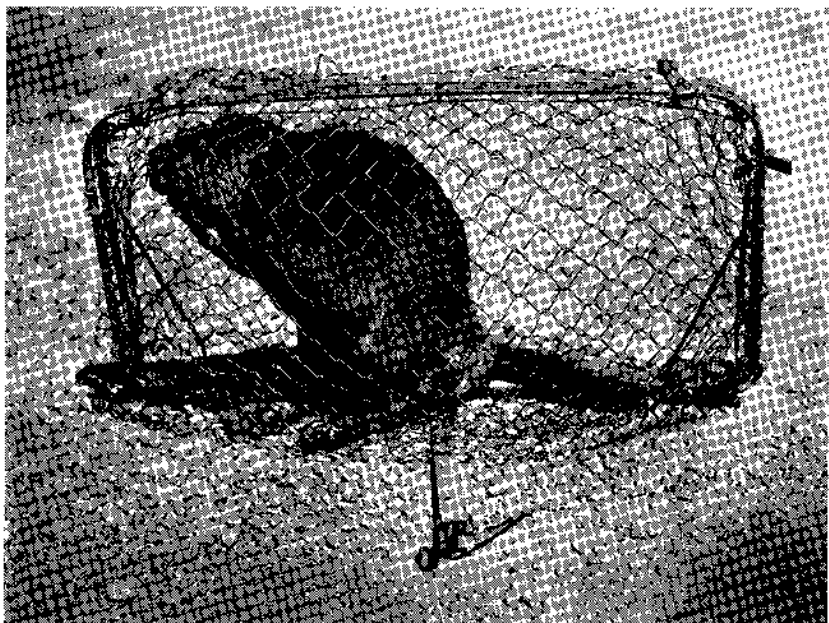


FIG. 26. The Bailey Live Beaver Trap with captured Shasta beaver. August 28, 1940.

interests, after carefully considering the probable immediate and future economic aspects involved.

2. If, in introducing a race into an area adjacent to that occupied by a native kind, there is any reasonable likelihood of the introduced animals ultimately spreading into the range of a native race, introduce the race whose native range is adjacent to the range where the transplantation is to be made.

3. In trapping live beavers for transplanting, use a type of trap that will reduce to a minimum the chances of injury to the animals, such as the Bailey trap (fig. 26). These traps should be visited by the trapper every few hours through the night to prevent the captured animal's injury or death through exposure or drowning. See Couch (1937) for information on methods of trapping and transplanting live

beavers. No fewer than 4, and if possible 6 or more, beavers should be introduced at each planting site. Since there is evidence that beavers may not be monogamous (Grinnell, Dixon, Linsdale, 1937, p. 681), there should be as many, or more, females planted as there are males.

4. In some instances where beavers are doing local damage, instead of trapping the animals it might be desirable to cause them to move of their own accord from the place where the damage is being done. For this reason an effort should be made to learn methods, other than trapping, of discouraging beavers from living in places where they are undesirable.

5. An essential part of any management plan for beavers involves making known to landowners the value of the animals to the public and to the individual. This is only a natural part of presenting a fair and relatively complete picture of the beavers' activities, especially in areas, as for example in the delta, where they cause damage. There the system of issuing permits to a few individuals to trap beavers may result in overemphasizing the undesirable features of the animals' activity. To illustrate, if one of these trappers depends, as a means of livelihood wholly, or even in part, on selling the fur of trapped beavers, or even if his job is on a salary basis for the purpose of removing only the animals which are causing damage, he may cause landowners to take the attitude that beavers are harmful, when in fact it previously had not occurred to them that the beavers were doing damage to their property. Indeed, it seems that under this system the landowners are apt to take the view that beavers are harmful when the animals are neutral in their effect, or in some instances beneficial.

6. (a) Should it turn out that beavers already introduced into the Sierra Nevada demonstrate the feasibility of propagating them in this area, it is recommended that animals for future plantings be obtained from stock built up from the nucleus of Shasta beavers still found in California.

(b) It is recommended also that any introductions of Shasta beavers in the Sierra Nevada be made where there is but slight likelihood of their extinction through dilution, namely through cross-breeding with other kinds of beavers.

(c) If the Shasta beavers succeed as well as other kinds of beavers already introduced in the Sierra Nevada, the latter (out-of-State) animals in a given watershed should be harvested as a fur crop down to, and including, the last individual. After a lapse of time sufficient to permit the wildlife technician to satisfy himself that no foreign stock remains, the stream should be restocked with native beavers.

(d) A program looking to this end should be inaugurated at once, because in the first place if benefits are to be gained through the establishment of beavers in the Sierra we should begin reaping the benefits as soon as possible, and secondly, if the out-of-State beavers (from Idaho and Oregon) now living in California increase in number, they could be more easily replaced now than later.

7. The study here reported upon indicates that there is considerable habitat within the range of the golden beaver now unoccupied. In much of this habitat it is judged that the beavers would cause little or no inconvenience and would yield a valuable return in fur. In these areas

it seems that animals should be released. Two such areas are the upper part of the Stanislaus River near Oakdale and the ox-bow lakes adjacent to the Sacramento River near Chico; ranchers in each of these areas have expressed their desire to have beavers introduced there, and all were willing to give the introduced animals protection.

8. Within the range of the golden beaver the largest population exists in the delta, the area where the animals cause the most damage and inconvenience. There are, therefore, two reasons for removing beavers from the delta region: first, to lessen damage, and secondly, to provide breeding stock for the other areas. To a limited extent the same policy could seemingly be applied in northeastern California in the range of the Shasta beaver.

9. The Sonora beaver is now generally, even though sparsely, distributed over the available habitat. Increase in the number of beavers there would seem to require, not transplantation, but protection of the existing stock, whereupon it is thought that now unoccupied habitat would soon be occupied by natural movements of the animals.

10. Protection of the kind that is afforded by general recognition, on the part of the public and landowners, of the desirability of shielding beavers from molestation by poachers, would be an important, and necessary, factor in successfully propagating the golden and Shasta beavers.

11. Effective protection of this kind obviously is to be expected in farmed areas, where beavers often are a nuisance to the ranchers, only if the landowners have the opportunity to share in the benefits conferred by a sizable population of beavers through harvesting the fur from a part of the annual increase. This is a necessary feature of any arrangement for effectively restoring and maintaining the beavers in farmed areas. Furthermore, the most complex part of the legal structure needed to put a program of this kind in operation already exists. The trespass law of California provides the landowner with the right to exclude from his premises all those who would compete with him in harvesting the crop of beaver fur. The part of the legal structure which yet needs to be set up is that providing for an agreement between the landowner and a representative of the State Division of Fish and Game which allows the landowner to take for fur a part of the annual increase when both he and the representative of the State agree that the population warrants a harvest.

LITERATURE CITED

Bradt, Glenn W.

1938. A study of beaver colonies in Michigan. *Jour. Mamm.*, vol. 19, pp. 139-162.

Bryant, H. C.

1915. California's fur-bearing mammals. *California Fish and Game*, vol. 1, pp. 96-107.

Cook, David B.

1940. Beaver-trout relations. *Jour. Mamm.*, vol. 21, pp. 395-401.

Couch, Leo K.

1937. Trapping and transplanting live beavers. U. S. Dept. Agric. Farmers' Bull. no. 1768, pp. 1-18.

Dale, Harrison Clifford

1918. The Ashley-Smith explorations and the discovery of a central route to the Pacific 1822-1829. A. H. Clark, Cleveland. Pp. 1-352, frontispiece map, 4 illus.

Duflot de Mofras, Eugene

1844. Exploration du territoire de l'Oregon, des Californies et de la mer Vermelle, exécutée pendant les années 1840, 1841 et 1842. In 2 vols. and atlas. Vol. 1, pp xii + 524, 8 pl. (Arthus Bertrand, Editeur). A. Bertrand, Paris.

Elliot, T. C.

1910. The Peter Skene Ogden journals/editorial notes by T. C. Elliot. Oregon Hist. Jour., vol. 11, pp. 201-222.

Grinnell, Joseph; Dixon, Joseph S.; and Linsdale, Jean M.

1937. Fur-bearing mammals of California. Their natural history, systematic status, and relations to man. In 2 vols. Vol. 2, pp. xvi + 377-777. Univ. Calif. Press, Berkeley.

Nidever, George

1937. The life and adventures of George Nidever (1802-1883). Edited by William Henry Ellison. Pp. xi + 128. Univ. Calif. Press, Berkeley.

Pattie, James O.

1930. The personal narrative of James O. Pattie of Kentucky, edited by Timothy Flint. Pp. xlii + 428. Lakeside Press, Chicago.

Sullivan, Maurice S.

1934. The travels of Jedediah Smith. Pp. 11-195, frontispiece, map, illus. Fine Arts Press, Santa Ana, California.

Wilkes, Charles

1844. Narrative of the United States exploring expedition during the years 1838, 1839, 1840, 1841, 1842. In 5 vols. and atlas. Vol. 5, pp. xv + 591, illus., maps. Sherman, Philadelphia.

Transmitted October 8, 1941.

o

it seems that animals should be released. Two such areas are the upper part of the Stanislaus River near Oakdale and the ox-bow lakes adjacent to the Sacramento River near Chico; ranchers in each of these areas have expressed their desire to have beavers introduced there, and all were willing to give the introduced animals protection.

8. Within the range of the golden beaver the largest population exists in the delta, the area where the animals cause the most damage and inconvenience. There are, therefore, two reasons for removing beavers from the delta region: first, to lessen damage, and secondly, to provide breeding stock for the other areas. To a limited extent the same policy could seemingly be applied in northeastern California in the range of the Shasta beaver.

9. The Sonora beaver is now generally, even though sparsely, distributed over the available habitat. Increase in the number of beavers there would seem to require, not transplantation, but protection of the existing stock, whereupon it is thought that now unoccupied habitat would soon be occupied by natural movements of the animals.

10. Protection of the kind that is afforded by general recognition, on the part of the public and landowners, of the desirability of shielding beavers from molestation by poachers, would be an important, and necessary, factor in successfully propagating the golden and Shasta beavers.

11. Effective protection of this kind obviously is to be expected in farmed areas, where beavers often are a nuisance to the ranchers, only if the landowners have the opportunity to share in the benefits conferred by a sizable population of beavers through harvesting the fur from a part of the annual increase. This is a necessary feature of any arrangement for effectively restoring and maintaining the beavers in farmed areas. Furthermore, the most complex part of the legal structure needed to put a program of this kind in operation already exists. The trespass law of California provides the landowner with the right to exclude from his premises all those who would compete with him in harvesting the crop of beaver fur. The part of the legal structure which yet needs to be set up is that providing for an agreement between the landowner and a representative of the State Division of Fish and Game which allows the landowner to take for fur a part of the annual increase when both he and the representative of the State agree that the population warrants a harvest.

LITERATURE CITED

Bradt, Glenn W.

1938. A study of beaver colonies in Michigan. *Jour. Mamm.*, vol. 19, pp. 139-162.

Bryant, H. C.

1915. California's fur-bearing mammals. *California Fish and Game*, vol. 1, pp. 96-107.

Cook, David B.

1940. Beaver-trout relations. *Jour. Mamm.*, vol. 21, pp. 395-401.

Couch, Leo K.

1937. Trapping and transplanting live beavers. U. S. Dept. Agric. *Farmers' Bull.* no. 1768, pp. 1-18.

Dale, Harrison Clifford

1918. The Ashley-Smith explorations and the discovery of a central route to the Pacific 1822-1829. A. H. Clark, Cleveland. Pp. 1-352, frontispiece map, 4 illus.

Duflot de Mofras, Eugene

1844. Exploration du territoire de l'Oregon, des Californies et de la mer Vermellie, exécutée pendant les années 1840, 1841 et 1842. In 2 vols. and atlas. Vol. 1, pp xii + 524, 8 pl. (Arthus Bertrand, Editeur). A. Bertrand, Paris.

Elliot, T. C.

1910. The Peter Skene Ogden journals/editorial notes by T. C. Elliot. Oregon Hist. Jour., vol. 11, pp. 201-222.

Grinnell, Joseph; Dixon, Joseph S.; and Linsdale, Jean M.

1937. Fur-bearing mammals of California. Their natural history, systematic status, and relations to man. In 2 vols. Vol. 2, pp. xvi + 377-777. Univ. Calif. Press, Berkeley.

Nidever, George

1937. The life and adventures of George Nidever (1802-1883). Edited by William Henry Ellison. Pp. xi + 128. Univ. Calif. Press, Berkeley.

Pattie, James O.

1930. The personal narrative of James O. Pattie of Kentucky, edited by Timothy Flint. Pp. xlii + 428. Lakeside Press, Chicago.

Sullivan, Maurice S.

1934. The travels of Jedediah Smith. Pp. 11-193, frontispiece, map, illus. Fine Arts Press, Santa Ana, California.

Wilkes, Charles

1844. Narrative of the United States exploring expedition during the years 1838, 1839, 1840, 1841, 1842. In 5 vols. and atlas. Vol. 5, pp. xv + 591, illus., maps. Sherman, Philadelphia.

Transmitted October 8, 1941.