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PROBLEMS ASSOCIATED WITH BEAVER IN STREAM OR FLOODWAY MANAGEMENT

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ABSTRACT: In California, beaver (Castor canadensis) were first recognized for their value as a furbearer. Additionally, in many areas, beaver are considered desirable if not essential components of stream and wetland ecosystems. Where beaver and human activity overlap, beaver have become nuisance animals causing direct damage through dam building, flooding, bank denning, and loss of agricultural crops. Other problems such as the threat of levee failure and subsequent flooding, increases in undesirable brush growth due to a raised water table, restricted access due to flooding, and an increased mosquito population resulted in the Department of Water Resources (DWR) developing a beaver management program. In 1984, DWR entered into a long-term agreement with the U. S. Department of Agriculture (USDA) Animal Damage Control (ADC) program to eliminate a large existing population of beaver and remove subsequent reinvading individuals from a 20-mile stretch of man-made Cherokee Canal in Butte County, California. In addition, existing dams, lodges, dens, and heavy brush growth were removed in an attempt to insure the flood safety of the project and modify the existing habitat making it less suitable for reinvading beavers. Both the costs and results of this program are discussed, as well as the long-term management strategy for this project.

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HISTORY OF BEAVER IN CALIFORNIA

Native beaver populations in California have undergone dramatic changes throughout recorded history. Beaver were once common on most of the streams in the northern, central, and southeastern parts of the State (Tappe 1942). During the early 19th century, traders and fur trappers began to extensively harvest the wealth of furbearing mammals in California. High demand for beaver pelts attracted large fur companies which systematically trapped large numbers of animals throughout the State. In 1839, a governmental export tax on beaver pelts combined with dwindling beaver populations resulted in fewer animals being taken (Hensley 1946). A few trappers chose to pursue remaining beaver populations by trapping increasingly inaccessible areas until 1911 when State legislation was passed prohibiting their take.

Beaver populations increased dramatically as a result of the 1911 protective legislation, to the point that farmers were experiencing damage and fearful of the potential damage recovering beaver populations might do. In 1917, the law was amended to allow the take of depredating animals and again in 1925 to allow the take of any beaver for its fur. Large-scale trapping once again threatened the population and its continued existence in California and resulted in the beaver season being closed from 1932 -1937 (Seymour 1979). During this time, private individuals, the U. S. Forest Service, and the California Division of Fish and Game began live trapping, transporting and releasing beaver in an attempt to increase their populations and expand their current range (Tappe 1942). As a result, beaver populations have increased and expanded to fill most of their historical range.

BEAVER AS A RESOURCE

Beaver were first recognized for their fur quality and value as furbearers. The high demand for their furs in the early to mid-1800s combined with a competitive fur price and a large accessible population resulted in the extensive harvest of this resource. While average pelt prices have increased slightly over the last 45 years (see Table 1), the value of other furbearer pelts has increased more significantly (DFG 1986). Considering the recent rates of inflation, beaver pelt prices provide less than optimal incentive to commercial trappers. This, combined with a high investment in time to set and check trap sets and to skin successful catches, has resulted in a decreasing interest in beaver as a commercial furbearer (sec Figure 1).

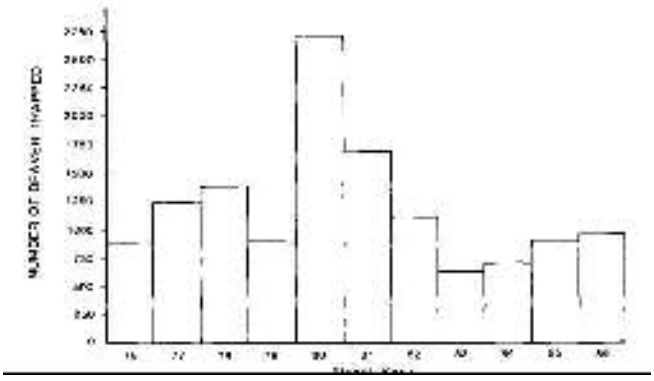

Fig. 1. Number of beaver commercially trapped in California.

Table 1. Number of beaver commercially trapped and average beaver pelt price.

YEAR	NO. OF BEAVER COMMERCIALLY TRAPPED	AVERAGE PELT PRICE ($)
1948	843	17.42
1949	-0-	-0-
1950	1,511	9.18
1951	690	14.19
1952	1,642	6.79
1953	690	5.87
1954	947	4.88
1955	1,006	7.66
1956	1,467	6.92
1957	2,247	5.45
1958	1,755	5.75
1959	1,838	5.69
1960	1,703	7.59
1961	2,002	7.16
1962	1,366	7.17
1963	1,606	7.58
1964	1,651	8.10
1965	1,679	7.31
1966	1,686	8.06
1967	1,384	8.92
1968	1,184	9.30
1969	1,542	11.41
1970	1,301	8.71
1971	539	4.90
1972	817	9.79
1973	1,709	10.44
1974	1,053	6.95
1975	855	7.00
1976	856	15.00
1977	1,210	10.00
1978	1,474	8.50
1979	902	14.31
1980	2,639	21.29
1981	1,680	13.69
1982	1,090	9.44
1983	682	7.87
1984	739	9.16
1985	904	9.53
1986	1,019	7.82

While the beaver's value as a fur resource has decreased, the understanding of its importance as a component of wetland ecosystems continues to grow. As early as the 1930s, Scheffer (1938) described the value of the beaver meadow complex later defined by Ives (1942). He describes early successful efforts to initiate and create this phenomenon through the controlled live trapping and release of beaver by the Soil Conservation Service and the Washington State Game Department on several streams in the State of Washington. The beaver meadow complex recognizes that beaver dams dissipate erosional velocities of water by creating a broader stairstep, riffle-pool profile which slows water and traps sediment. Over time, the water table is increased, beaver ponds silt in, and a succession of vegetation results (Scheffer 1938). Additionally, beaver play an important role in nutrient cycling. Beaver consume less than one-fourth of the total wood they cut (Duncan 1984). This surplus wood plus digestive wastes slowly decompose creating an anaerobic environment. This results in a slower cycling of nutrients, an increase in the growth of bacteria and algae and subsequent impact on the rest of the food chain (Bergstrom 1985).

More recently, land and water use managers have successfully introduced beaver into damaged streambeds with the intent of reversing stream degradation and restoring valuable riparian habitat (Apple etal. 1985). It has been well documented that riparian zones provide valuable nesting, feeding, and loafing areas for a proportionately high number of vertebrate species.

Beaver impact on fisheries differs greatly depending on specific circumstances. In restoring damaged fisheries, Mueller (1973) discusses the need for the use of specific structural improvements and subsequent removal of existing beaver dams. Research on the study area on Beaver Creek in northeastern Wyoming indicates that these small beaver dams across an already shallow degraded stream profile resulted in an increase in water temperatures. These higher temperatures were lethal to the survival and growth of brook trout. Conversely, on healthy streams, Mueller (1973) recognizes the value of beaver dams, which contribute to the value and success of the fishery. Bergstrom (1985) also identifies the value of beaver activity on healthy streams. Nutrient cycling in beaver pools can result in faster growing fish and an increased juvenile survival rate. Beaver dams increase water surface area, improve water storage during drought and result in less damage from floods.

BEAVER - HUMAN CONFLICT

Legislative protection, a scarcity of natural predators, and an active transplanting program probably all contributed to beaver returning to their historical ranges in California. In Canada, despite the loss of habitat and record fur trapping, beaver populations have increased (Ingle-Sidorowicz 1982). In the United States, beaver populations began to increase in the 1900s (Miller 1983). Whether as a result of expanding beaver populations or simply an increase in man/beaver conflict as a result of more intensive land use, the number of beaver taken in California under animal damage control depredation permits is increasing (USDA 1986). In the last ten years, the number of beaver taken in California under depredation permits has increased over 500 percent with the majority of the increase occurring in the years 1983 through 1986 (see Figure 2).

Where human activity and beaver activity overlap, conflict is likely to result. Much of the damage caused by beaver is a result of dam building, bank denning, tree cutting, and flooding (Miller 1983). These are some of the very same activities which can be viewed as desirable in wilderness

areas or where certain habitat or streambed restoration is desired. In urban or residential areas, beaver damage includes cutting or girdling of shade and ornamental trees and shrubs, burrowing which can undermine yards and structures and flooding of walks, roadways, parks, and golf courses. In rural areas, flooding and feeding activities sometimes cause extensive damage to row crops, orchards, and timber (Wade and Ramsey 1986). Beaver may cause the washout or flooding of roads, pasture and irrigation ditches and they have been suspected as primary or contributing factors in serious levee failures which have resulted in extensive flooding.

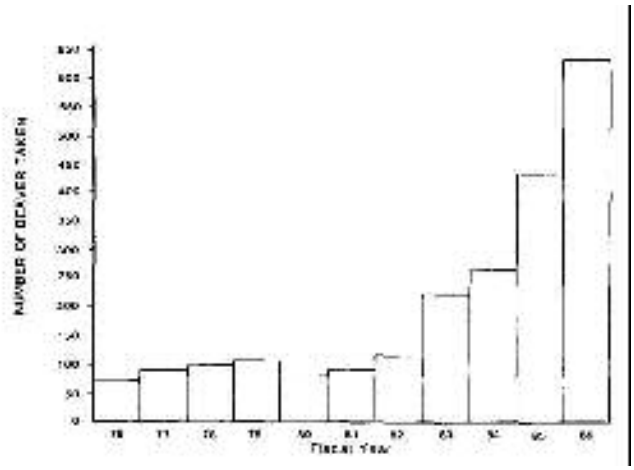

Fig. 2. Number of beaver taken in California through the Federal Animal Damage Control program.

In 1980, levee breaks occurred on six islands or tracts in the Sacramento-San Joaquin Delta in California (DWR 1980). Information collected by visual sightings and surveys in the affected areas verify large numbers of beaver living and denning in the general vicinity of the levee failures. As an indication of beaver populations at Lower Jones Tract, 18 beaver lodges were identified within 200 yards of the levee break (Magagnini 1980). This confirmed threat to delta levees, along with the presence of other serious problems such as erosion and subsidence, prompted DWR to conduct an extensive inspection of all Sacramento-San Joaquin Delta levees in the fall of 1980. This survey identified an additional six islands where beaver were considered to be a threat to levee safety (DWR 1980).

As a result of the six Sacramento-San Joaquin Delta levee failures, the combined cost of flood fight assistance provided by both DWR and the U. S. Army Corps of Engineers in 1980 was approximately 2 million dollars. Resulting flood damage claims submitted to the Office of Emergency Services and the Federal Emergency Management Agency totaled in excess of 30 million dollars (DWR 1980).

In California, the USDA's ADC program is responsible for the removal of the majority of depredating beaver and certain other pest animals (USDA 1987). Relatively few beaver depredation permits are issued to private property owners or managers, most of which are issued for the protection of agricultural or forest lands (DFG 1985). The ADC program in California operates on a three-way cost-share program with funding being provided by Federal, State, and County agencies. In the last ten years, the economic value of beaver damage resulting in direct removal of the animal through the ADC program has increased substantially (see Figure 3). Some examples of reported resource losses caused by beaver would include apple and other fruit and nut trees, rice, sugar beets, ornamental plants, timber, injury to livestock, irrigation structures, roads, and dikes or water impoundments. The combined value of damage done by beaver over the last ten years in California, as reported in the ADC annual report, is in excess of one million dollars.

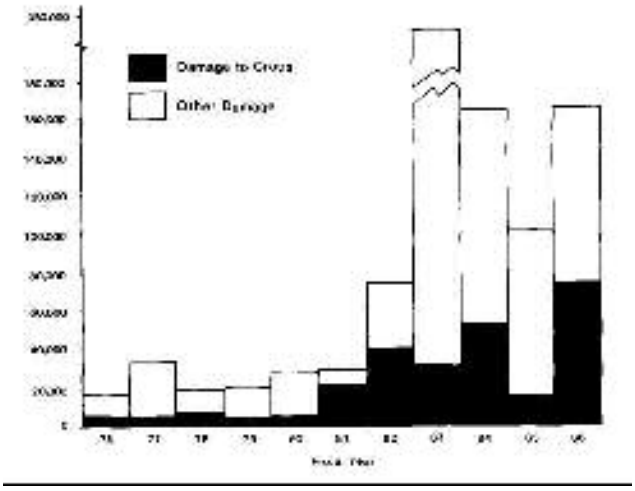

Fig. 3. Dollar value of beaver damage in California.

DWR BEAVER MANAGEMENT

In the fall of 1984, DWR entered into an ongoing agreement with the ADC program to eliminate a large existing beaver population and remove subsequent reinvading individuals from Cherokee Canal in Butte County, California. The Cherokee Canal is a man-made flood control channel maintained by DWR. The channel is approximately 450 feet across, 20 miles long, has a relatively shallow gradient, and is bordered by levees on both sides. It receives inflow from Cottonwood and Dry Creeks as well as agricultural and storm drainage. Normal maintenance for the channel includes the periodic removal of brushy species, primarily willows and cottonwoods, on the overflow areas within the channel and the removal of drift and debris piles which might hamper or divert floodflows. Occasional post-flood repairs are necessary when floodflows have resulted in scouring or erosion. Normal summer flows are confined to a single or split main channel. Every attempt is made to leave a subclimax riparian fringe of vegetation along the main channel.

After the 1983-84 flood season, it was felt that several key areas in the Cherokee Canal flood channel must be

cleared to insure the continued safe operation of the flood control project.

For several years prior to 1984, mechanical clearing and other heavy equipment operation had been impossible because of extensive beaver activity and nonseasonal flooding. The year- round raised water table had resulted in an increased rate of brush growth and an excessive mosquito nuisance problem. Beaver dams along the length of the project diverted both ponded water and floodflows away from the main channel towards levees, thus increasing the likelihood of erosion or subsidence. Additionally, drainage culverts from adjacent agricultural areas were repeatedly plugged by beaver.

During the summer of 1984, three consecutive unsuccessful attempts were made to remove the existing beaver dams and drain the areas needed to be cleared without disturbing the beaver population. Each day following the dam removal resulted in a new dam constructed by beaver the previous night. At this point, it was decided that removing the beaver would provide the only effective solution to the problem. An initial survey of the area by the Butte County ADC trapper and DWR staff identified abundant beaver signs including trails, slides, scent mounds, and extensive feeding activity. Eight major dams, five above-ground lodges, and the likelihood of numerous bank dens were also recorded. The existing beaver population was estimated between 75 and 100 animals.

Implementation of the ADC beaver control program was delayed until late fall of 1984 because of the extensive recreational use of the area. Rather than posting the area and attempting to keep hunters out, it was felt that waiting for high water would better suit the program. After obtaining a depredation permit from the California Department of Fish and Game (DFG) and notifying local property owners, the program was initiated. No. 330 Conibear traps in dam, slide, and dive sets, and No. 2 snares in slide sets were used by ADC personnel. Mason et al (1983) identified No. 330 conibear in dive sets to be superior to other conibear sets, all sets of No. 2 snares, and No. 4 Victors for controlling beaver. Additionally, with authorization from the local law enforcement authority, day shooting and night shooting with night vision goggles was also used.

Between November 1984 and January 1986,60 beaver were removed from Cherokee Canal (see Table 2). This required the expenditure of 272 ADC person hours at a total estimated cost of $3,265. With the reduction in beaver pressure, DWR was able to begin draining the area by removing existing beaver dams in the spring of 1985. Existing lodges were also destroyed by bulldozing, then burning to prevent future use by reinvading animals. Once the heavy equipment work had begun, it was discovered that there were many more beaver dams, including many secondary dams, than originally thought. In many areas, siltation was a significant problem necessitating a complete excavation of the primary channel. Even after removing primary and secondary dams, the area did not drain and dry well creating treacherous working conditions. Throughout this project it was necessary to use two large caterpillar tractors; the bigger of the two was used as an anchor while the second was operated from it with a winch and cable, considerably increasing costs. The total estimated cost for activities directly involved with the removal of the existing dams was $52,000. An additional $67,000 of clearing of brush species in the flood channel was done later in 1985.

Between February 1986 and August 1987, 16 beaver were taken. It was felt that most of these animals had simply evaded the initial trapping program but a few had reinvaded from adjoining areas. No beaver dams or lodges required removal at this time. An additional $8,000 was spent to complete the mechanical clearing initiated in 1985. The 1986-87 flood season identified two areas in the Cherokee Canal which would require clearing to insure the continued safe operation of the project. However, in California, 1987 was considered a "critical" water year with rainfall totals throughout the State averaging only 65 percent of normal. These very dry weather conditions resulted in the drying of many small waterways. The abundant food supply and available water in the Cherokee Canal channel resulted in a tremendous inflow of beaver into the Cherokee Canal area. As expected, this beaver population increase resulted in the construction of numerous new beaver dams. Unfortunately, the two areas targeted for clearing were also affected by this non-seasonal flooding prohibiting the use of the heavy equipment necessary to complete the clearing work. In August 1987 the Butte County ADC trapper was alerted to the problem. Because of the need to complete the clearing work before the 1987-88 flood season and the ADC trappers' heavy workload, it was decided that the two areas needed to be cleared would be extensively trapped while other populations within the channel would be left undisturbed at that time. In the fall and winter of 1987,19 beaver were removed from two locations within Cherokee Canal. The affected dams were subsequently removed at a cost of $2,800, and the clearing was completed at a cost of $ 18,300.

Over the next three years beginning in 1988, approximately $600,000 has been budgeted for the removal of silt in a 3-mile stretch of the Cherokee Canal channel. If possible, this area will be trapped prior to the onset of excavation to minimize the displacement of resident beaver populations into adjoining areas. In remaining areas, it is expected that beaver will continue to create a nuisance problem. DWR's agreement with DFG requires the preservation of certain habitat areas within the Cherokee Canal channel for the protection of all wildlife species. This translates into a perpetual food supply for beaver. This, combined with the "preserve"-like quality of the channel and the inability to exclude beaver, will result in perpetual population of these animals in this area.

It is important to clarify that DWR's goal is not to eliminate beaver in the Cherokee Canal channel but rather to insure the safe operation of this flood control project. Since it would be virtually impossible to eliminate the current population and prevent any further reinvasion, the key to successful management of this area is the establishment of a

Table 2. Summary of Department of Water Resources beaver control program.

Date	# Beaver Taken Conibear			Cost of Beaver Take Person Hrs. $		Cost of Mechanical Work Dam Removal Related Clearing	
	Shot	Snare					
11/84-1/85	13	2	0	91	1,192	0	0
2/85-1/86	32	12	1	181	2,073	$52,000	$67,000
2/86-1/87	0	16	0	66	751	0	$8,000
2/87-1/88	9	10	0	104	1,170	S 2,800	$18,300
Total	54	40	1	442	5,186	$54,800	$93,300

threshold of tolerance. They key points of this management strategy are as follows:

1. Overall beaver population levels must be kept low, low enough so that it is possible to control animals in problem areas.

2. No dens or lodges will be permitted within 50 feet of the levee. This is to reduce the likelihood of structural failure of the levee caused by excavation or prolonged saturation of the levee section.

3. Any beaver population or family group which is directly impacting the safe operation of the flood control channel will be removed. Examples of this would include damming of inlets or outlets, plugging culverts, or dams which affect bridge crossings.

4. When engineering evaluations determine that clearing or excavation is necessary, any beaver causing swampy conditions that inhibit necessary vegetation and sediment control will be removed from the area where the work is to be done, and downstream to the degree necessary to allow the area to drain.

The use of this sort of management strategy will necessitate an ongoing agreement with the ADC program to keep beaver populations low and remove animals in trouble spots. However, it also recognizes beaver as a wildlife resource which is an asset in cooperating with other agencies such as DFG and U. S. Fish and Wildlife Service.

CONCLUSIONS

Historically, beaver as a fur resource have had a significant impact on California's economy and development. Today, beaver still have a limited value as a fur resource but their most significant economic impact comes from the damage they do in both urban and agricultural areas. As urban and agricultural areas continue to develop, the number of beaver/human conflicts will increase.

DWR has been involved in managing beaver in the Cherokee Canal since 1984. In the last 3-1/2 years, 95 beaver have been removed from the Cherokee Canal channel at a cost of $5,186. An additional $148,100 has been expended on the removal of dams and lodges and other related clearing. By clearly defining project objectives and establishing a management strategy, DWR has been able to maintain its primary objective of safe and effective flood control while permitting a small population of beaver to remain in the area.

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