# BIOLOGICAL STATUS OF MOUNTAIN LIONS IN CALIFORNIA

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## INTRODUCTION

Mountain lions (Felis concolor) symbolize wilderness. The "wild west," a supreme predator, supreme quarry, destroyer of wildlife (game and nongame), livestock, and "trophy" hunting. They are the epitomy of controversy in California. In this paper we will review the history of management and present legal status of mountain lions in California, the political situation leading to the present status, and some of the biological factors that have been controversial, particularly relating to population status and trends.

## HISTORY

The following chronology shows the historical events leading to the present situation.

| | |
|---|---|
| 1907 | $20.00 bounty instituted. |
| 1909 | Federal predator control began. |
| 1917 | Bounty $20.00 for male, $30.00 for female. |
| 1919 | State hired Jay Bruce and C. W. Ledshaw to hunt lions. |
| 1937 | State hired trappers. |
| 1939 | Two State lion hunters added to cover northwestern and southern California (Total = 4). |
| 1945 | Bounty $50.00 for male, $60.00 for female. |
| 1946 | Jay Bruce retired. |
| 1947 | C. W. Ledshaw retired. |
| 1953 | Four State lion hunters still employed. |
| 1959 | End of state program. |
| 1963 | End bounties, lions not protected. |
| 1969 | Lions protected by classification as big game animal. |
| 1970-71 | Hunting authorized (4,953 permits, 118 taken). |
| 1971 | Most federal lion control ended. |
| 1971 | Moratorium on lion hunting enacted by legislature. |
| 1975 | Moratorium extended. |
| 1983 | Moratorium extended. |
| 1986 | Moratorium ended. |
| 1986 | Bill introduced to prohibit hunting until 1990. |

Various counties of the state offered their own lion bounties in addition to the state bounty with beginning and ending dates differing. Durward Allen (1954: pages 272-273) describes the illegal importation of coyote scalps for the purpose of claiming a $5.00 bounty in California between 1891 and 1895. Allen says a "smoothly operating interstate industry" was formed throughout the western United States to claim the bounties for coyote scalps. It is possible that similar importation occurred with mountain lion bounties. In 1939 about one-fourth of lions bountied were taken by state-paid full-time lion hunters (True 1940). These lions undoubtedly were taken in California. It has been documented that Bruce and Ledshaw bountied more lions (922) than the next 10 hunters (920) (McLean 1954). About 100 hunters claimed bounties besides the state-paid lion hunters (True 1940).

When the bounties were removed in 1963, direct financial incentive was gone, but lions still could be hunted without restriction and without a hunting license for sport and for preventing livestock depredation. When the lion became a big game animal, hunting was restricted to regulations established by the California Fish and Game Commission. During the first hunt in 1970, tags were sold for $1.00 and were purchased by many deer hunters hoping to see a lion.

Between 1971 and 1985 the U.S. Fish and Wildlife Service (the federal animal damage control organization) was involved in controlling problem mountain lions. In 1985 they began to train more dogs and hunters to accommodate increasing numbers of reported livestock depredations from mountain lions.

The pattern of legislation and regulation in most western states was similar. Beginning in the late 1950s there were political pressures to preserve the mountain lion. In most states wildlife biologists supported protection of the lion as a big game animal, favoring removal from classification as nongame or predator. Also, many biologists believed it was wasteful and distasteful for a paid hunter to have to kill a mountain lion. Often in such cases the carcass was not used or was fed to the hunter's dogs. There was a demand for sport hunting of the lion and many biologists believed that if a lion was to be killed, it should be done by someone who would pay for the privilege and would use the carcass beneficially. This reasoning, coupled with protectionist interests, obtained classification of the mountain lion as a big game animal in most western states during the 1960s. California was the only western state to enact a ban on hunting mountain lions.

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In 1985, an effort to extend the moratorium on lion hunting failed. The legal status reverted to the law in effect prior to the first moratorium in 1971. The Fish and Game Commission acted quickly to provide continuity with recent practice in depredation control measures, but has not yet acted to establish sport hunting of mountain lions in California. By law, the Commission must consider hunting regulations at three public meetings in March and April and cannot finalize any changes until that time.

## MOUNTAIN LION POLITICS

Support for legislative action relating to lions in California has been extremely polarized, although the organizations and individuals involved represent a complete spectrum of possible opinions. On the protectionist side, numerous organizations representing views from extreme to moderate banded together as a "Mountain Lion Coalition" for concerted action. On the pro-hunting side, an equally diverse set of organizations was less cohesive, but no less active. We have identified six characterizations to represent the continuum of opinion found in these two camps: 1) anti-killing; 2) anti-hunting; 3) predation must be controlled; 4) let the Fish and Game Commission decide individual species issues; 5) pro-hunting; 6) "the only good lion is a dead one."

During 1984, Senator Robert Presley sponsored a bill to continue the existing moratorium on sport hunting of mountain lions. The present moratorium was due to expire December 31, 1985. The bill, as amended, did not establish a moratorium, but did effectively prohibit hunting until December 1989. The net result was passage by a very slim margin of two votes in the Assembly. The Governor vetoed the bill and returned jurisdiction over the mountain lion to the Fish and Game Commission.

During 1985 the Fish and Game Department had under consideration a proposal for a research project to test the hypothesis that mountain lions were controlling the North Kings deer herd which had been depressed by other factors. The test was to be removal of lions and observation of the deer herd. The director had authority to approve the research project but elected to consult with the Commission because of the sensitive nature of the issue. Placing the project on the Commission's agenda brought it to public attention. This proposal, while not yet approved, was an issue in the legislative hearings. Pro-moratorium factions had argued that there was no scientific proof that a deer herd could be controlled or maintained in a depressed state by mountain lions (see Mech 1985). After the Governor's veto of the bill, pro-hunting factions requested that the Fish and Game Commission consider removing the lions in the research project by sport hunting. The resulting anti-hunting arguments in the press and at public hearings created confusion between original research purposes and a perceived management purpose of increasing the deer herd by and for sport harvest. The pro-moratorium coalition was in the position of opposing the research that would help provide the information they claimed was needed during the legislative sessions. The Commission has not taken final action at the present writing.

In February 1986 Assemblyman Richard E. Floyd introduced Assembly Bill 2865, essentially identical to the final version of the pro-moratorium bill of 1985. The practical effect of this new introduction was to pressure the Fish and Game Commission to more carefully consider the effect approval of the pending research project in the North Kings area would have on the legislature.

During arguments in the legislature, lions often were referred to as "threatened," "endangered" or "rare" on the basis of declines in bounty payments and rarity of lion observations. A population estimate was provided by the Department of Fish and Game of 4,800 lions in California. This estimate was based on the assumption that a declining number of bounties paid during the bounty-hunting years represented a reduction in the mountain lion population of the same magnitude. When pressed, pro-moratorium advocates supported a previous Department estimate of 2,400 based on Sitton (1977). Sitton used an estimated density of lions determined in interviews, verified by two radio-collar studies applied to the total lion habitat in the state. Other issues raised included the amount and accuracy of information needed to manage the mountain lion, and the question of public safety.

## BIOLOGICAL STATUS

The biological status of mountain lions can be determined from information obtained through management efforts or through formal research. In this paper, formal research is defined as a project for which a formal proposal was prepared and an extensive preconceived study plan was followed. All other projects are termed "management" regardless of what organization did them.

### Management Information

Management information includes records of human contacts, claims for damage, records of bounty payments, impromptu surveys, and evaluation of management programs. A record of human contacts with wild mountain lions in California indicates that the mountain lion may be inhabiting marginal habitats in which it has formerly been an infrequent visitor. Pooling information from our own files and from the California Department of Fish and Game (Richard A. Weaver, pers. comm.), we have identified 40 human/mountain lion contacts involving "close encounters"--not just sightings--but potentially dangerous situations (Table 1). These include lions found recently in Auberry, Auburn, Chico, Folsom, Fresno, Oceanside, Simi Valley and various developed areas in Siskiyou and Orange Counties.

Concerned citizens in and around Scott Valley, Siskiyou County, reported 49 sightings of mountain lions during 1984 and January 1985. Seven of these in 1984 were of the "close encounter" variety, hence biased the 1984 count of close encounters since no similar survey was available in other years.

Table 1. Human/mountain lion encounters in California 1970 through February 1986.

| Year or period | Number of encounters |
|---|---|
| 1970-1979 | 4 |
| 1980-1981 | 1 |
| 1982 | 3 |
| 1983 | 2 |
| 1984 | 10 |
| 1985 | 18 |
| 1986 (through February) | 2 |

Attacks on Humans

The increasing number of "close encounters" elicits an immediate question about public safety. Should we be alarmed at a mountain lion in a tree in a backyard, or in a schoolground (representative of several of the incidents in the above list)? Janis E. Schmidt (1986) compiled published records of mountain lion attacks on humans (Figure 1). Her report includes newspaper accounts from our files, collected since about 1980, but for earlier data is restricted to books, professional journals and a sportsman's magazine. Of the 66 attacks reported, 23 were fatal to humans.

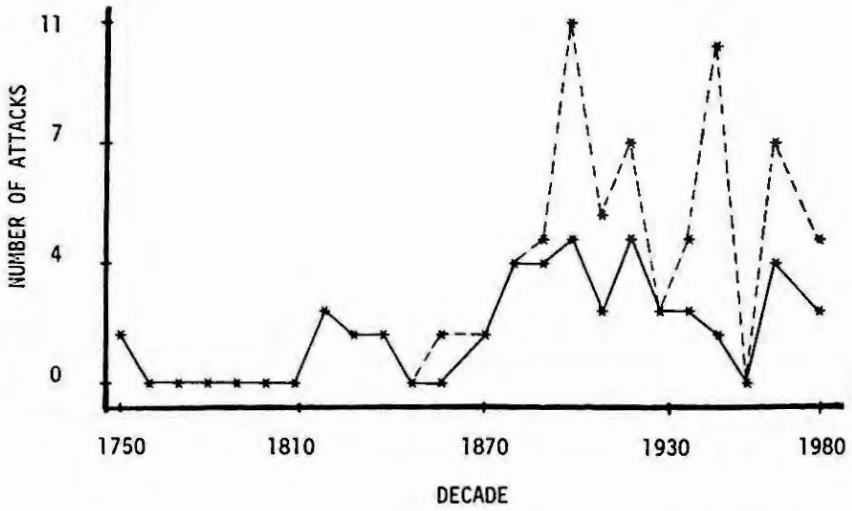


Figure 1. Number of mountain lion attacks on humans in the United States (solid line) and the western hemisphere (dashed line) during each decade from the 1750s to 1980s.

Most of the reported attacks have occurred in the United States, with Canada next. Vancouver Island seems to have an unusual number of attacks reported, especially recently. A few of the reported attacks occurred in South and Central America.

It is possible that more of the attacks that occur are reported in the United States than in other countries. Also, attacks prior to 1900 may not have reached publication and may not be represented proportionally. Other factors that probably influence the increase in attacks reported prior to 1900 involve the increase in non-Indian settlement of the American West, which ended in 1900 when the Imperial Valley of California was settled.

The slight overall decline in mountain lion attacks from 1900 to 1980 is more difficult to explain. One possible explanation is that the mountain lion was forced into less-inhabited areas as farming settlements created more human activity. This explanation is contradicted by our data on "close encounters" and by numerous sightings in areas heavily used by humans in California (Gross and Fitzhugh 1985, 1986; Fitzhugh et al. 1985) and by McLean (1954, page 161), but is supported by Van Dyke et al. (1986) for Arizona and Utah. Another possibility is that the end of the gold rush in various parts of the West removed lone humans from lion habitat in considerable numbers, thus reducing close encounters. However, there was an increase in human activity during the Depression of the 1930s (McLean 1954) which was not reflected in attacks. A third possibility is that increased predator control, which began in the early part of the century, reduced lion numbers and particularly the transient animals that may have wandered into human-inhabited areas. Reduction of transients can occur without appreciably affecting the resident lion population of an area (Murphy 1984). Whether this happened in California is discussed

later with respect to bounty payments, but not with respect to other forms of predator control. The recent slight increase in attacks following the low in the 1960s recorded during the decade of the 1970s may be a function of increased reporting and availability of news articles in our files.

Of the 39 attacks in the United States, 31 were in or west of the Rocky Mountains, and six were in California. In California, one attack involved two people and one involved three. Of the nine people involved, six were children. Three attacks were non-fatal, but two people involved in one of the non-fatal attacks later died of rabies. (This is the only recorded incident of people contracting rabies following a lion attack.) One of the attacks in California was provoked; the others were not.

Condition of the lion may be inferred in 17 of the 66 reported attacks. Sick or emaciated lions were identified in 10 of the 17 cases. It is possible, however, that young transient animals in good health may have been misclassified as "emaciated" because of low weight and youthful configuration. Also, 10 of 36 classifiable attacks occurred near cities or other inhabited locations. Another six were near rural homes, leaving 20 of 36 in remote areas.

Several reliable observers have commented on a different reaction of mountain lions in captivity to children than to adults (Rob Gross, formerly Cooperative Extension, University of California; Bill Clark, California Department of Fish and Game; Bud Bristow, Arizona Game and Fish Department; pers. comm. 1985, 1986). They observed heightened interest toward children, and in one case actual charging behavior that was not directed toward the adults present. Schmidt (1986) reported that of 16 attacks since 1950, only half were on children. Since children probably frequent lion habitat less often than adults, the equal selection may actually indicate a preference for children over adults.

We conclude that attacks by mountain lions on humans are rare, but they do occur. A predisposing element may be sickness or starvation, but apparently healthy lions attacked humans in 41% of known cases. Lions watching school bus stops, or living in developed areas where children may look like prey, should cause concern. Most of the time the lion will not attack, but the data show that it may happen again in California.

## Depredation Records

The Department of Fish and Game has used the number of livestock depredation incidents as a measure of lion population increase (Figure 2). These are confirmed incidents, not occurrences. To be included, an attack on livestock must: 1) be found; 2) be found soon enough to make pursuit feasible and identification as a lion incident possible; and 3) be of sufficient concern that the rancher wants to obtain a permit to remove the lion. The first two criteria often are not met. Therefore, confirmed attacks do not represent the number of attacks occurring but are a subset.

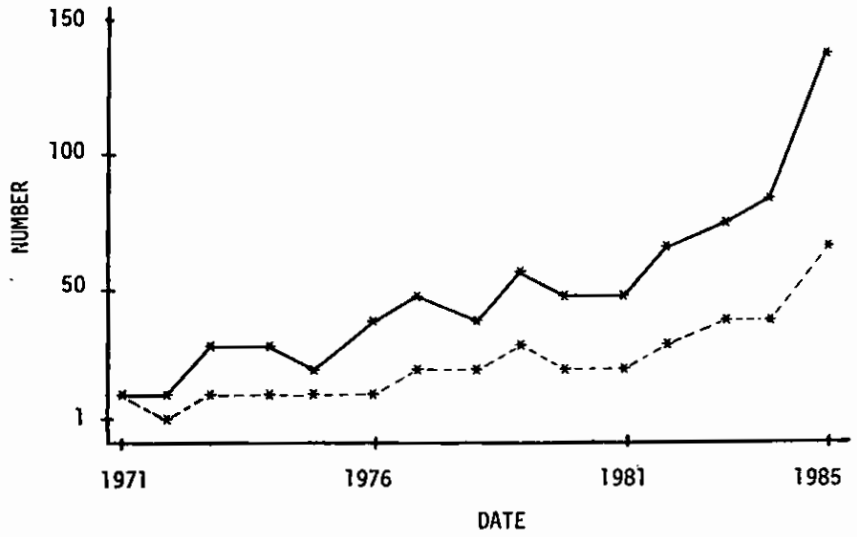


Figure 2. Number of confirmed mountain lion depredation incidents (solid line) and mountain lions killed for depredation control (dashed line) in California from 1971 to 1985 (from Mansfield 1986).

Some local surveys have provided results similar to the depredation reports. In Glenn County, Fremont L. Bell (1984) surveyed ranchers, trappers, and highway patrolmen, asking them to list their lion sightings from 1980 through 1984. Robert L. Willoughby (1985) surveyed ranchers in Butte County in a similar fashion. While the samples were small (Figure 3), it is interesting to note the similarity in shape between these graphs and the livestock depredation incidents.

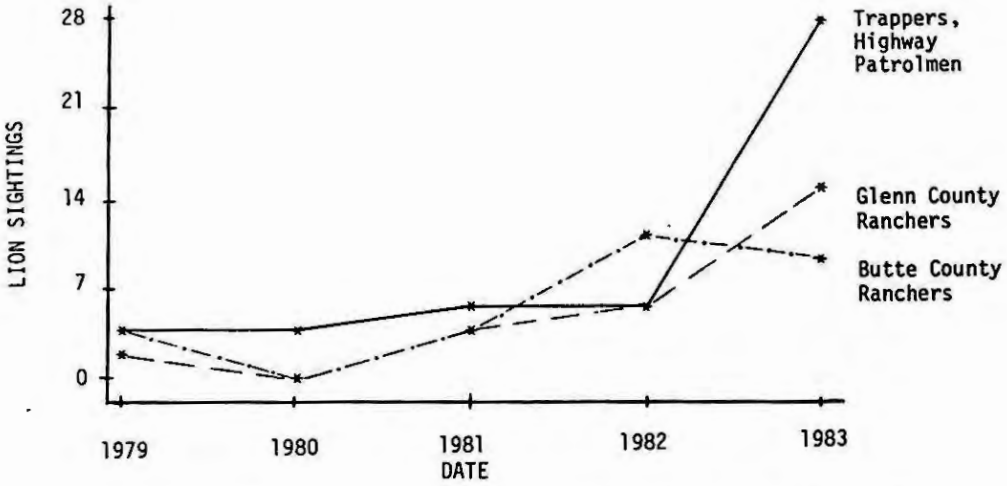


Figure 3. Mountain lion sightings in California reported from 1979 to 1983 in Glenn County by trappers and highway patrolmen (N=8), Glenn County ranchers (N=19), and Butte County ranchers (N=34).

Terry Mansfield (1986) reported that the depredation control program in Placer County mentioned earlier, in which five lions were removed prior to or during sheep grazing, appeared to be successful in reducing the amount of depredation compared to previous years. The Department of Fish and Game will attempt to continue the program and obtain more records on which to base conclusions.

Research Projects

The amount of effort devoted to mountain lion studies in California is greater than has been recognized. Tables 2 and 3 list the people involved in mountain lion studies in California and the general topics they are investigating. There are 17 formal research projects, 13 of which are completed or substantially under way. In addition, there are 12 management studies.

Table 2. Formal mountain lion research projects in California.

| Name | Report or publication | Subject | Applicability |
|---|---|---|---|
| Sitton, et al. | 1977 | Density, life history | Statewide |
| Koford, C. B. | 1976, 1978 | Track surveys | Statewide |
| Kutilek, et al. | 1980, 1981, 1983 | Population index, tracks | Statewide |
| Clinite, E. W. | 1981 | Scats | Statewide |
| Hopkins, R. A. | 1981 | Density, home range | Statewide |
| Smith, T. E. | 1981 | Food habits | Statewide |
| Neal, D. L. | 1984 | Decline of deer | Regional |
| Bertram, R. C. | Neal, 1984 | Population index, tracks | Statewide |
| Boland & Briden | 1985 | Food habits | Statewide |
| Fitzhugh & Gorenzel | 1985a,c | Population index, tracks | Statewide |
| Harvey & Stanley | Continuing | Yuma subspecies | Regional |
| Hopkins, R. A. | Continuing | Ecology | Statewide |
| Smallwood, K. S. | Continuing | Statewide population index | Statewide |
| Smallwood, K. S. | Continuing | Identifying tracks | Statewide |
| Fitzhugh et al. | Pending funds | Genetics and diseases | Statewide |
| Froke, J. | Pending funds | Density, home range, urban habits | Statewide |
| Barrett, R. H. | Pending funds | Mountain lion population model | All areas |

All of these studies are an attempt to put lion management on a biological, factual basis, and away from the emotional, unscientific basis subject to political whim that now exists. California has more mountain lion studies than most states that have continued to hunt lions, but numerous studies also have been conducted in Utah, Idaho, New Mexico, Arizona, Colorado and Montana.

MOUNTAIN LION POPULATIONS

Records of human contacts, sightings of lions and livestock depredations previously discussed suggested recent increases in lion populations. Track surveys in prime habitat did not detect a recent

Table 3. Applied research and expert evaluations regarding California mountain lions.

| Name | Report or publication | Subject | Applicability |
|---|---|---|---|
| Bruce, J. C. | 1953 | Habits, population, techniques | Statewide |
| McLean, D. D. | 1954 | Life history, population | Statewide |
| Hert & McMillan | 1955 | Habits, techniques | Statewide |
| USFS, Sequoia NF | Unpublished | Tracking | Local |
| USFS, Cleveland NF | Unpublished | Tracking | Local |
| Sitton, et al. | 1978 | Predation | Statewide |
| Bell, F. L. | 1984 | Survey of observations | Local |
| Fitzhugh, E. L. | 1985 | Genetic isolation | Regional |
| Fitzhugh, et al. | 1985 | Marin County track count | Local |
| Gross & Fitzhugh | 1985 | Marin County observations | Local |
| Kary, D. L. | 1986 | Placer County tracking | Local |
| Willoughby, R. L. | 1985 | Survey of observations | Local |
| Gross & Fitzhugh | 1986 | Fresno, Madera County track count | Local |

change in population, possibly because such a change may be expressed more in marginal habitats. However, there is some evidence in the North Kings study area that more overlap is occurring in home ranges than previously occurred (Donald L. Neal, pers. comm.).

The 57-year record of bounties paid in California has been used to represent mountain lion population changes (Figure 4). Anderson (1983) and Roberson and Lindzey (1984) summarized maximum and minimum lion densities from intensive research studies in the western United States (Table 4). The maximum and minimum figures are from different research studies. Applying density figures to the area of mountain lion habitat, we obtained upper and lower limits of possible mountain lion numbers (Table 5). Because all habitats in any large area cannot be uniformly good or bad, the maximum and minimum figures are certain to be extremes not likely to be realistic. We therefore calculated a mean value as a benchmark for comparison. We adopted the area for lion habitat in the entire state as that used by the California Department of Fish and Game (Weaver 1982). Habitat areas for the counties were obtained by estimating the proportion of the county containing lion habitat and applying that proportion to published figures for size of the county. For reasons of geography and accessibility we pooled data from Humboldt and Trinity Counties, and from Los Angeles, Riverside, San Bernardino, and Orange Counties. For southern California, only the mountain ranges west of the desert were included. A proportion of Humboldt and Trinity Counties is occupied by high mountains which would be only seasonal range for mountain lions. No deduction was made for this area, so the figures will overestimate population in those counties.

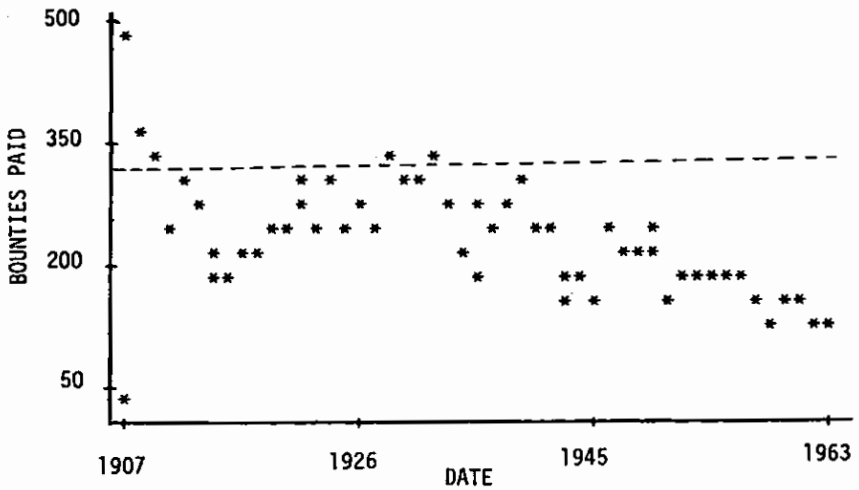


Figure 4. Number of mountain lion bounties paid in California from 1907 to 1963. Dashed line represents estimated harvest level for sustained yield using minimum population estimate (Table 6).

Biologists have usually accepted a sustained-yield harvest rate for mountain lions of 25% to 30% of the resident population per year (Tsukamoto 1984; also see Murphy 1984). Applying the 25% rate to population figures in Table 5, we obtained upper and lower bounds on calculated sustainable harvest figures for the state and for the sampled counties (Table 6). Applying these figures to the numbers of bounties paid annually by county (from California Department of Fish and Game records), we found that the maximum limit never was exceeded; the mean was rarely exceeded; but the minimum was exceeded numerous

Table 4. Mountain lion densities in the western United States.

| Reported in | Lions/259 $Km^2$ (100 $Mi^2$) Maximum | Minimum |
|---|---|---|
| Anderson (1983) | 12.5 | 1.2 |
| Roberson & Lindzey (1984) | 17.8* | 1.0 |
| California Studies (except Koford) | 8.9-11.1 | 1.8 |

*Winter deer "yarding" situation.

Table 5. Calculated populations of mountain lions in California.

| Area | Habitat ($Mi^2$) | Square mile/population 11.1/100 | 1.8/100 | Mean |
|---|---|---|---|---|
| Statewide | 70,000 | 7,742 | 1,281 | 4,511 |
| Humboldt & Trinity Counties | 6,764 | 748 | 124 | 436 |
| Southern California* | 3,435 | 398 | 63 | 215 |
| Tulare County | 2,661 | 294 | 49 | 172 |
| Fresno County | 2,982 | 330 | 54 | 192 |

*Los Angeles, San Bernardino, Riverside and Orange Counties west of the desert.

times, particularly in Humboldt, Trinity, Lake, Mendocino and Tulare Counties (Table 7, Figures 5 and 6). Bounties paid in Tulare County had a level trend; the apparently upward trend was not statistically significant at the 95% level. Therefore, if bounty data reflect population status, the real sustainable yield level was not exceeded in Tulare County. In Humboldt, Trinity, Lake and Mendocino Counties, it appears possible that bounty hunting may have reduced the mountain lion population. It is not likely, based on these biological calculations, that bounty hunting significantly decreased the statewide population or populations in other counties.

Table 6. Calculated sustainable harvest of mountain lions.

| Area | Population and harvest Maximum | 25% | Minimum | 25% | Mean | 25% |
|---|---|---|---|---|---|---|
| Statewide | 7,742 | 1,935 | 1,281 | 320 | 4,511 | 1,127 |
| Humboldt & Trinity Counties | 748 | 187 | 124 | 31 | 436 | 109 |
| Southern California* | 398 | 99 | 63 | 15 | 215 | 53 |
| Tulare County | 294 | 73 | 49 | 12 | 172 | 43 |
| Fresno County | 330 | 82 | 54 | 13 | 192 | 48 |
| Lake & Mendocino Counties | 389 | 97 | 63 | 15 | 226 | 56 |

*Los Angeles, San Bernardino, Riverside and Orange Counties west of the desert.

Table 7. Number of years bounties paid exceeded sustainable (25%) harvest.

| Area | Population basis Maximum | Minimum | Mean |
|---|---|---|---|
| Statewide | 0 | 4 | 0 |
| Humboldt & Trinity Counties | 1 | 31 | 1 |
| Southern California* | 0 | 11 | 0 |
| Tulare County | 0 | 22 | 1 |
| Fresno County | 0 | 2 | 0 |
| Lake & Mendocino Counties | 0 | 21 | 0 |

*Los Angeles, San Bernardino, Riverside and Orange Counties west of the desert.

Using regression analysis, we examined the relationship between time and number of bounties paid. Figures 4 to 6 represent the range of values. These tests do not establish a causative relationship; they only tell the nature of and probability of the relationship between the two factors. For these tests, we used the counties with more than 475 lions bountied during the 57-year period. These counties would be expected to show the greatest negative relationship between time and bounties paid if there was an effect of hunting on the lion population. We included Fresno County and the southern California counties because Jay Bruce (1953) and Carl Hert (Hert and McMillan 1955) were active in those areas, even though the total of bounties paid was less than 475.

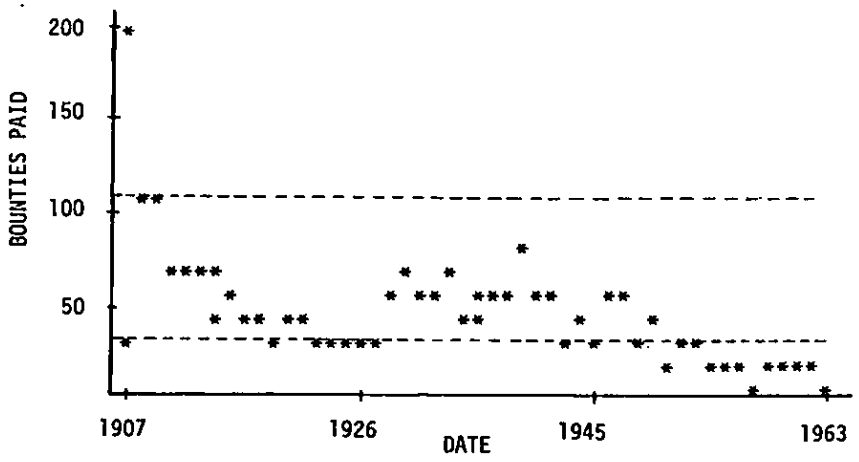


Figure 5. Number of mountain lion bounties paid in Humboldt and Trinity Counties, California, from 1907 to 1963. Dashed lines represent estimated harvest level for sustained yield using minimum (lower line) and mean (upper line) population estimates (Table 6).

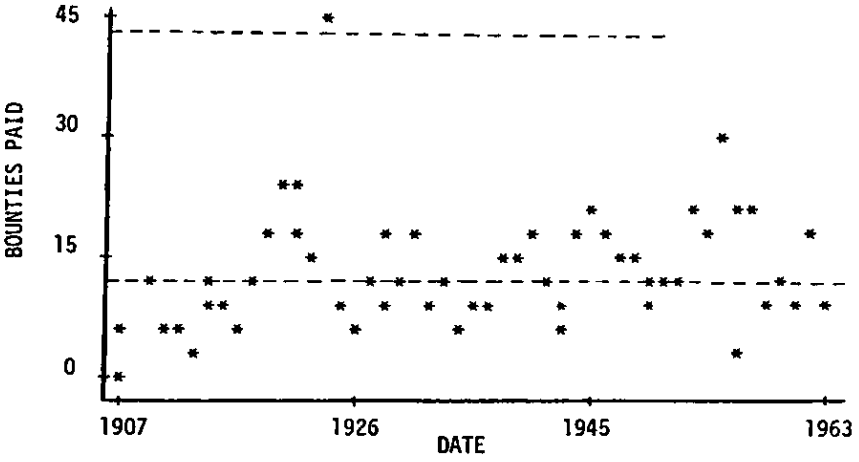


Figure 6. Number of mountain lion bounties paid in Tulare County, California, from 1907 to 1963. Dashed lines represent estimated harvest level for sustained yield using minimum (lower line) and mean (upper line) population estimates (Table 6).

The range of possible data values is somewhat limited by the naturally widespread occurrence of lions. Therefore, any collection of data over a 57-year period, analyzed by years, would be expected to give a statistically significant linear correlation value. Such was the case at the 95% level except for Fresno, Kern and Tulare Counties. However, the R-squared values were so low in most cases the regression failed to explain the relationship. No county had an R-squared value greater than .33 (Table 8). The R-squared value denotes the proportion of the total variability of bounties paid that is explained by the time factor.

Data representing the entire state, with 12,461 bounties paid over 57 years, had a slope (b value in the formula a + bx) of -2.4, and was significantly different from b = 0 ($t = -4.82$, 55df, $p = <.001$). There appears to be a real decline in bounties paid statewide during the 57 years. The R-squared value of .30 associated with the regression indicates that the time sequence accounts for only 30% of the relationship. Other factors affected the relationship more than the time factor. In other words, regression against time has very little meaning regardless of the statistical significance.

Also, we see from Table 8 that counties having fewer than 900 bounties (average 15 per year or less) had slopes (b) of less than 0.2, either plus or minus. Moreover, the level of harvest among this group did not appear to affect the slope. Only two counties (Lake-Mendocino and Humboldt-Trinity) harvested more than 900 lions, and their regressions had slopes of -.36 (R-squared = .23) and -1.07 (R-

Table 8. Relationship of time and bounties paid.

| Area | Number bounties paid | slope (b) | t | Probability (b = 0) | R-Squared |
|---|---|---|---|---|---|
| California | 12,461 | -2.40 | -4.82 | .001 | .30 |
| Humboldt & Trinity Counties | 2,170 | -1.10 | -5.23 | .001 | .33 |
| Lake & Mendocino Counties | 1,362 | -0.37 | -4.15 | .001 | .24 |
| Monterey County | 891 | +0.15 | +2.11 | .040 | .07 |
| Shasta County | 806 | -0.12 | -4.62 | .001 | .28 |
| Tulare County | 690 | +0.04 | +0.73 | .470 | .01 |
| Siskiyou County | 675 | -0.17 | -2.27 | .030 | .08 |
| Kern County | 591 | -0.03 | -0.74 | .460 | .01 |
| Santa Barbara County | 499 | -0.12 | -2.29 | .030 | .09 |
| Southern California* | 326 | -0.14 | -2.65 | .010 | .11 |
| Fresno County | 246 | +0.05 | +1.58 | .120 | .04 |

*Los Angeles, San Bernardino, Riverside and Orange Counties west of the desert.

squared = .33). Bounties claimed from Lake and Mendocino Counties were 1,362 and from Humboldt and Trinity Counties, 2,170. These represent annual average harvests of 23 and 38 lions, respectively. Similarly, the R-squared values remained less than 0.15 (except for Shasta County, 0.27) until more than 900 lions were removed. The results are sufficient to show that the number of lions removed apparently did not affect the regression except possibly at very high rates of removal in one or possibly two county groups.

Both biological and regression analyses show that removal of lions during the bounty years probably did not affect lion populations (in the case of the biological analysis) or the number of bounties paid (in the case of the regression) except in Humboldt, Trinity, Lake and Mendocino Counties where very high levels of hunting may have occurred. Why, then, the significant negative regressions? What were the "other factors" that were associated with the regressions? Without much more research we cannot tell. We will list some possibilities in order to stimulate the additional research required to determine which ones were important (also see McLean 1954).

(1) Increased law enforcement, preventing interstate shipment of lions to be bountied.

(2) Changes in bounty levels, both state and county, and interactions as county bounties were enacted and cancelled.

(3) Administrative changes in hiring of lion hunters and state trappers.

(4) Cultural changes as people retired who were raised "backwoods" in the 19th Century.

(5) Increased educational opportunities for veterans and urban jobs following World War II.

(6) Increased human presence in lion habitat and increased economic needs during the Depression. McLean (1954) documented this, concluding that periods of high wages and good earning conditions resulted in less hunting pressure on mountain lions.

## MANAGEMENT POTENTIAL

### Present Management

No hunting seasons have been established so present management involves livestock depredation control and nonconsumptive uses. Losses of livestock to mountain lions may be unimportant from an industry-wide standpoint, but they can be devastating to an individual operator because of the tendency lions have for multiple killing. At present, livestock depredation control is achieved by professional hunters using dogs. Snares and traps can be very effective (Hert and McMillan 1955) but have not been widely used in recent years.

It may be possible in specialized situations to reduce loss from mountain lions by changing livestock management techniques. Guard dogs, toxic collars, and aversive conditioning are not appropriate techniques against mountain lions because of the lions' methods of hunting and killing. Lions appear to prey more upon animals the size of deer, so cattle ranchers may reduce losses by not leaving calves in lion habitat. This usually is not practical. Sheep losses may be avoided only by removing sheep from lion habitat or by removing lions. Of course, the former solution would not be acceptable to sheep ranchers if they are to stay in business. Removing the offending lion has appeared to be effective in reducing livestock losses in some areas and not in others. This method does not eliminate the initial loss suffered by the rancher but may prevent subsequent losses, at least until another lion assumes the same home range or another transient animal wanders through.

While no research has established the efficacy of general lion population reduction for livestock depredation control, what is known of lion biology indicates that it should be effective. The argument

has been presented that lion removal would increase the number of transient animals in an area. On the assumption that transient animals kill more livestock, that would increase depredation instead of decrease it. We know of no research that supports this theory. On the contrary, Murphy (1984) reported that under heavy hunting pressure, there were no transient lions, since each wandering animal apparently claimed a territory as soon as an empty area was found. It is known that females with young kill more frequently and within a shorter radius or home range. Kills also may be more frequent as young are being taught to hunt.

The primary nonconsumptive use allowed at present is the permit to pursue lions with dogs without killing the lion. In 1985, 112 permits were issued and resulted in a considerable number of reports of lions treed (see Kary 1986). It is possible that proper advertising could result in houndsmen receiving fees for guiding photographers and other enthusiasts on non-appropriative lion hunts.

Population and Trend Estimates

Moratorium advocates have insisted that biologists should know accurately, with statistical significance, the size of the lion population before contemplating a hunting season. Biologists do not know how many lions are in California. If they did know, the figure might soon be outdated. A population estimate may not be needed for management, as a trend index, coupled with data on lion removals, will illustrate the effect of hunting on the population.

However, to obtain an accurate population figure we would divide the state into six strata, north to south, and subdivide each stratum into appropriate east-west sections by major habitat and climatic zones (chaparral, timber, woodland, desert, and eastside-westside climatic zones). This would result in 55 sites requiring study, each one 300 to 400 square miles in size. Each site would constitute one sample in a statistical sense. Each site would be studied by a combination of radio tracking and track counts (if sufficient houndsmen were available). This study would yield a good figure for management use, but would not be susceptible to statistical testing unless at least three sites in each substratum were studied. Using only one site each, the estimated cost would exceed $1.5 million (1985 base).

It may be appropriate to estimate density of lions in local areas where intensive hunting is to occur or where other lion-related problems exist. Tools available to estimate density are: records from pursuit permits, in which sportsmen report the number of lions treed and released; systematic track counts; radio-tracking studies; various other anecdotal information mentioned earlier. Track counts appear to be suitable for a population index (Van Dyke et al. 1986), and we have enough experience and data in California to adapt a track count technique quickly to our conditions (Fitzhugh and Gorenzel 1985b,c), especially if we could monitor radio-collared populations during severe hunting pressure. The least expensive method would be to systematically conduct a track count once every 2 weeks for at least four counts. Once the routes were established, this would cost 8 man-days per year per area. We do need more research to identify observer variability and lion track variability, although the technique can be used now.

For political and management reasons an estimate is needed for the statewide mountain lion population trend. One method for this trend count is under development. This method involves binomial recording of presence or absence of lion tracks in routes established in randomly selected blocks of land throughout the state.

CONCLUSION

We have much more information on mountain lions in California than has been generally recognized. Of course, we can use more, as with all wildlife species, but there is enough to allow management of the mountain lion according to biological principles. We should also recognize that management of the mountain lion affects many individuals and interest groups and is therefore a political decision. The political process is an important aspect of lion management.

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