

# MANAGEMENT OF THE BULLFROG RESOURCE IN CALIFORNIA

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Abstract. The bullfrog (*Rana catesbeiana*) was introduced into California in the early part of the present century. The extensive marshland habitat of the Central Valley was ideally suited to this species and it quickly spread. However, bullfrogs have become scarce in recent years. Sport and commercial users tend to blame each other's activities for this decline. It is also apparent that agricultural practices, such as "clean-farming" and the use of pesticides in adjacent croplands, have reduced the range and density of the bullfrog populations.

In late 1971 the California Department of Fish and Game initiated a study of the bullfrog problem. Background and life history data were collected in 1972. The basic life history of the bullfrog in California is similar to that in its native range in the East.

A large scale field survey was conducted in 1973. Seventeen "primary" canals were surveyed four times and 23 "secondary" canals were surveyed once. In general, bullfrog densities were lower in canals that were open to frogging than in canals that were closed to frogging.

Because of low bullfrog population densities in the Central Valley, the California Fish and Game Commission adopted regulations in 1974 which closed much of the Sacramento Valley to commercial frogging and placed restrictions on the commercial season in the San Joaquin Valley. The Commission also reduced both the bag limit and the open season for sport frogging in the Central Valley.

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## INTRODUCTION

The bullfrog was successfully introduced into California in the early part of the present century (Storer 1922). The extensive marshland habitat of the Central Valley was ideally suited to this species and it quickly spread throughout a large part of the State. However, in recent years there have been reports of a decline in bullfrog abundance in the Central Valley. Sport and commercial users tend to blame each other's activities for this

TABLE 1. Number of *R. catesbeiana* per Kilometer Observed in the Primary Study Canals During 1973

| Canals                            | County | First survey<br>(April 23 - May 17) |      | Second survey<br>(June 18 - July 18) |      | Third survey<br>(Aug. 6 - Sept. 5) |      | Fourth survey<br>(Oct. 3 - Nov. 8) |       |
|-----------------------------------|--------|-------------------------------------|------|--------------------------------------|------|------------------------------------|------|------------------------------------|-------|
|                                   |        | Adults                              | Imm. | Adults                               | Imm. | Adults                             | Imm. | Adults                             | Imm.  |
| <u>Control areas</u>              |        |                                     |      |                                      |      |                                    |      |                                    |       |
| Gray Lodge WR*                    | Butte  | 23.0                                | 3.9  | 28.4                                 | 25.5 | 39.6                               | 38.5 | 30.8                               | 46.7  |
| San Luis NWR*                     | Merced | 24.7                                | 1.1  | 16.3                                 | 0.4  | 8.1                                | 3.5  | 2.1                                | 4.5   |
| Sacramento NWR*                   | Glenn  | 108.7                               | 10.3 | 87.3                                 | 13.7 | 24.5                               | 3.1  | 29.2                               | 46.6  |
| <u>Sport areas</u>                |        |                                     |      |                                      |      |                                    |      |                                    |       |
| Colusa Main Drain                 | Colusa | 7.3                                 | 3.1  | 7.0                                  | 1.9  | 0.8                                | 0.4  | 5.2                                | 18.5  |
| Cherokee Drain                    | Butte  | 11.4                                | 0.2  | 5.0                                  | 0.2  | 2.0                                | 0.7  | -                                  | -     |
| Drain 833                         | Butte  | 2.9                                 | 2.1  | 1.9                                  | 3.5  | 0.4                                | 0.4  | -                                  | -     |
| Brush Canal                       | Glenn  | 2.3                                 | 0.8  | 20.7                                 | 6.0  | 30.3                               | 15.3 | 19.4                               | 231.6 |
| <u>Sport and commercial areas</u> |        |                                     |      |                                      |      |                                    |      |                                    |       |
| Wadsworth Canal                   | Sutter | 6.4                                 | 5.4  | 1.9                                  | 0.0  | 0.4                                | 0.2  | -                                  | -     |
| Morrison Slough                   | Sutter | 6.0                                 | 7.0  | 1.2                                  | 2.3  | 0.4                                | 0.2  | 3.5                                | 17.2  |
| Snake Slough                      | Sutter | 19.3                                | 28.4 | 7.9                                  | 6.2  | 4.8                                | 1.2  | -                                  | -     |
| Progress Slough                   | Sutter | 1.4                                 | 0.8  | 5.3                                  | 1.2  | 7.1                                | 0.7  | -                                  | -     |

\*WR = State wildlife refuge, NWR = national wildlife refuge.

decline. But, changing agricultural practices, such as marshland drainage and vegetation control along canal banks and the use of pesticides and herbicides, have also contributed to the reduction of bullfrog densities.

#### BACKGROUND

The reported decline of bullfrog densities and the resultant conflict between sport and commercial froggers led the State Fish and Game Commission to enact measures designed to reduce the harvest of bullfrogs by closing certain counties to commercial frogging, and by tightening of provisions under which frogs are taken commercially. Glenn and Colusa counties were closed in 1970 and Butte and Placer counties in 1971; these closures were temporary and were scheduled to terminate in April 1972. In the meantime, the Department was to investigate the bullfrog problem and report to the Commission before April 1972. Briefly, the study showed a lack of information sufficient to manage the bullfrog resource (Treanor and Nicola 1972). At the April 1972 Commission meeting, the Department recommended that a more intensive study be conducted and that the closures be continued until their impact on the bullfrog resource could be more fully evaluated. The Commission concurred and enacted the necessary measures. This report will briefly summarize the findings of this study. More detailed findings on sport and commercial exploitation, the management plan for the bullfrog resource, and the biology of bullfrogs in California are being prepared for publication (Treanor 1975; Treanor MS).

#### STUDY METHODS

To determine what impact sport and commercial frogging was having on the bullfrog resource required knowledge on bullfrog population densities in various canals. Since standard methods of estimating bullfrog populations in canals did not exist, I spent the summer of 1972 testing different procedures, and finally selected the direct-count method for making surveys.

A study section consisted of a 4.8 km (3 mile) length of canal. This was floated once per night and the total encountered over the distance floated was used as an estimate of bullfrog density.

Data on the impact of sport and commercial froggers on bullfrog populations were collected from 17 canals (called primary canals) which were to be surveyed four times during 1973. As time permitted, other canals (called secondary canals) were sampled once to have base-line data on as many canals as possible. In 1973, 274 km (170.25 miles) of primary canals and 103.2 km (64.1 miles) of secondary canals were sampled. Both primary and secondary canals were categorized as follows: (1) canals that received very little or no frogging pressure (controls), (2) canals subject to sport frogging only, and (3) canals which were frogged by both sport and commercial people.

During this study, the following biological aspects of the life history of bullfrogs in California were studied: (1) food habits, (2) age and growth, (3) fecundity, and (4) growth and transformation of tadpoles.

#### SURVEY RESULTS

Adults per kilometer in the primary control canals far outnumbered the other primary canals, except for Brush Canal in Glenn County (Table 1). There seems to be little difference in the number of adults per kilometer between the primary sport canals and the primary sport and commercial canals. In 43 of the 49 samples of frogged primary canals, the number of adult frogs was less than 12/km (20/mile), a density which I considered to represent a depleted population. Bullfrog densities tended to decrease during the year.

TABLE 1. Number of *R. catesbeiana* per Kilometer Observed in the Primary Study Canals During 1973 (Continued)

| Canals                            | County | First survey<br>(April 23 - May 17) |      | Second survey<br>(June 18 - July 18) |      | Third survey<br>(Aug. 6 - Sept. 5) |      | Fourth survey<br>(Oct. 3 - Nov. 8) |       |
|-----------------------------------|--------|-------------------------------------|------|--------------------------------------|------|------------------------------------|------|------------------------------------|-------|
|                                   |        | Adults                              | Imm. | Adults                               | Imm. | Adults                             | Imm. | Adults                             | Imm.  |
| <u>Sport and commercial areas</u> |        |                                     |      |                                      |      |                                    |      |                                    |       |
| East Side Sutter Bypass           | Sutter | 8.9                                 | 2.7  | 2.7                                  | 0.6  | 3.1                                | 3.3  | -                                  | -     |
| West Side Sutter Bypass           | Sutter | 7.5                                 | 28.0 | 14.2                                 | 3.2  | 2.7                                | 0.8  | 16.6                               | 10.9  |
| Colusa Main Drain                 | Yolo   | 8.5                                 | 11.4 | 5.6                                  | 1.1  | 0.2                                | 0.2  | 3.7                                | 176.0 |
| Main Drain                        | Kern   | 5.8                                 | 3.5  | 2.3                                  | 0.2  | 6.8                                | 71.2 | -                                  | -     |
| Agatha Canal                      | Merced | 7.9                                 | 26.7 | 2.3                                  | 2.1  | 16.0                               | 6.8  | 7.3                                | 7.5   |
| West Delta Drain                  | Merced | 10.6                                | 1.6  | 5.8                                  | 0.4  | 4.3                                | 0.0  | 11.8                               | 2.3   |

TABLE 2. Number of *R. catesbeiana* per Kilometer Observed in the Secondary Study Canals During 1973

| Canal                              | County | Type of frogging* | Date of survey | Adults | Immatures |
|------------------------------------|--------|-------------------|----------------|--------|-----------|
| Quint Canal                        | Glenn  | S                 | 5-29-73        | 3.5    | 3.0       |
| Willow Creek                       | Glenn  | S                 | 5-30-73        | 6.8    | 0.4       |
| Walker Creek                       | Glenn  | S                 | 5-31-73        | 24.4   | 5.0       |
| Buena Vista Canal                  | Kern   | S & C             | 6-11-73        | 1.2    | 163.7     |
| New Rim Ditch                      | Kern   | S & C             | 6-12-73        | 2.7    | 3.0       |
| Central Branch Kern Island Canal   | Kern   | S & C             | 6-13-73        | 10.6   | 57.2      |
| Western Canal                      | Butte  | S                 | 7-23-73        | 2.9    | 0.8       |
| Biggs Extension Canal              | Butte  | S                 | 7-24-73        | 28.8   | 7.5       |
| High Ditch                         | Colusa | S                 | 7-25-73        | 4.2    | 1.4       |
| Wilkins Canal                      | Colusa | S                 | 7-26-73        | 7.0    | 0.6       |
| Colusa NWR+                        | Colusa | U                 | 7-26-73        | 18.0   | 14.9      |
| Canal on south side of Pelger Road | Sutter | S & C             | 7-30-73        | 6.2    | 2.1       |
| Canal along Cranmore Road          | Sutter | S & C             | 7-31-73        | 3.9    | 2.1       |
| Drain 100                          | Butte  | S                 | 8-1-73         | 3.6    | 4.3       |
| Dry Creek                          | Butte  | S                 | 8-2-73         | 3.7    | 1.9       |
| Pheasant Canal (Knights Landing)   | Sutter | S & C             | 8-2-73         | 1.1    | 0.2       |
| Los Banos WR+                      | Merced | S                 | 8-8-73         | 3.7    | 0.3       |
| Colony Main Drain                  | Merced | S & C             | 9-17-73        | 10.6   | 2.3       |
| Arroya Canal                       | Merced | S & C             | 9-18-73        | 8.5    | 0.2       |
| Main Canal                         | Merced | S & C             | 9-20-73        | 7.4    | 1.7       |
| Colusa Main Drain                  | Glenn  | S                 | 9-26-73        | 35.9   | 84.3      |

\*U = unfrogged, S = sport frogging, and C = commercial frogging.

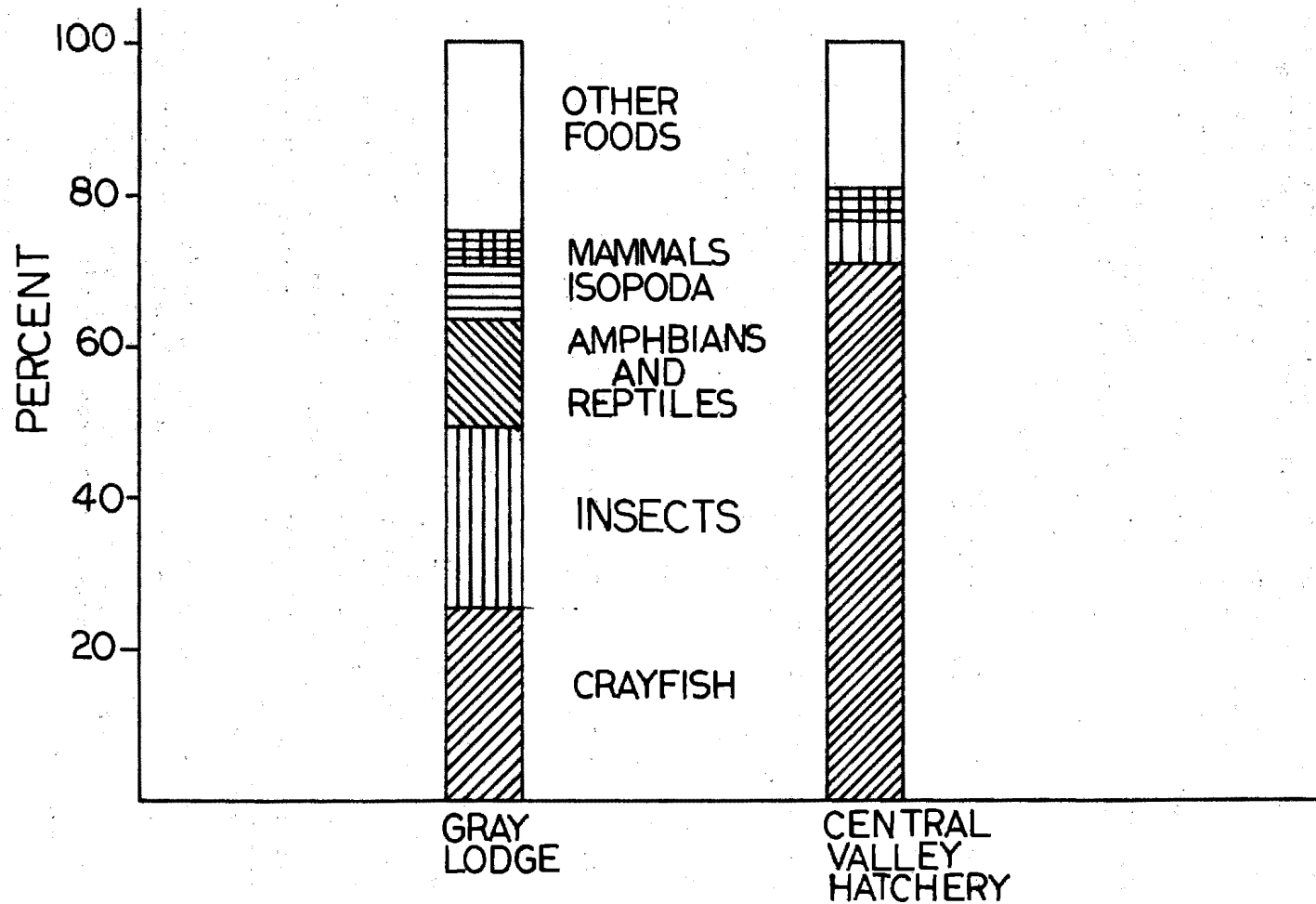
+WR = State wildlife refuge, NWR = national wildlife refuge.

TABLE 2. Number of *R. catesbeiana* per Kilometer Observed in the Secondary Study Canals During 1973 (Continued)

| Canal                   | County | Type of frogging* | Date of survey | Adults | Immatures |
|-------------------------|--------|-------------------|----------------|--------|-----------|
| Cental Irrigation Canal | Glenn  | S                 | 9-27-73        | 12.7   | 15.4      |
| Kern NWR+               | Kern   | U                 | 11-12-73       | 7.6    | 1.9       |



FIGURE 1. PRINCIPAL FOOD ITEMS OF BULLFROGS CAPTURED AT GRAY LODGE WILDLIFE REFUGE AND CENTRAL VALLEYS.



Bullfrog densities in the secondary canals were generally low, although variability was great (Table 2). This is probably due in part to sampling each canal only once, and over an extended time period (May to November). The 21 samples of frogged canals revealed adult frog counts lower than 12/km (20/mile) in 17 canals.

A total of 58 animal food groups was identified in the stomach contents of the 139 bullfrogs captured at Gray Lodge, a control area near Gridley (Treasurer MS). The major food categories were as follows: Crayfish, insects, amphibians and reptiles, isopods, and mammals (Figure 1). There were 26 animal food groups identified in the stomach contents of the 23 bullfrogs captured at Central Valleys Hatchery in Elk Grove. The major food groups were as follows: crayfish, insects, and mammals (Figure 1).

For each age group there was no appreciable difference between the mean lengths of bullfrogs from localities in the northern and southern portions of the Central Valley. Mean lengths of all bullfrogs combined at the end of the first, second, third, fourth, fifth, and sixth postmetamorphic years are 100.3, 126.9, 139.3, 157.8, 165.5, and 166.1 mm, respectively (Table 3).

There was extreme variability in fecundity of the 25 individuals sampled. Fecundity ranged from 16,514 to 78,749 eggs per female with a mean of 36,969 eggs.

#### DISCUSSION AND CONCLUSIONS

Bullfrogs are known to be voracious feeders and are said to eat anything that doesn't eat them first. Therefore, caution is required when comparing food habits from different habitats. Nevertheless, the general food habits of California bullfrogs were very similar to those of bullfrogs from other areas (Korschgen and Moyle 1955, Korschgen and Baskett 1963, Brooks 1964, and Fulk and Whitaker 1968). Crayfish (when abundant), insects, amphibians, reptiles, small mammals, spiders, and isopods are principal foods of the bullfrog.

Growth rates were remarkably uniform throughout the Central Valley, and were comparable to other regions in the United States (Schroeder and Baskett 1968).

The intensive survey of many canals in the Central Valley in 1973 revealed very low populations of adult bullfrogs, but did not demonstrate conclusive differences between adult bullfrog populations in canals which are sport frogged only and those which are open to both sport and commercial frogging. One reason for this may be that insufficient time has elapsed for recovery of the bullfrog populations in the four counties closed to commercial frogging. It is also possible that bullfrogs may be so vulnerable to frogging, as presently regulated, that sport frogging alone has depressed the populations. However, bullfrog abundance is strongly affected by many of man's influences; therefore, frogging alone accounts for only a small portion of the variance.

Regardless of the cause, bullfrog populations in the Central Valley are greatly reduced. The only readily feasible means of restoring harvestable populations is to reduce the current level of exploitation. These restrictions on take are important because the adult bullfrog is so vulnerable to frogging. Thus, some rather drastic revisions of frogging regulations were necessary.

Changes in the commercial regulations were made on May 31, 1974, when the Fish and Game Commission approved the following revisions to Section 658, Title 14, California Administrative Code:



TABLE 3. Mean Body Length According to Age Groups for the Northern and Southern Parts of the Central Valley in California<sup>1/</sup>

| Age Group |                  | North Valley | South Valley | All areas |
|-----------|------------------|--------------|--------------|-----------|
| 0         | N                | 7            | 2            | 9         |
|           | $\bar{X}$ length | 73.6         | 74.5         | 73.4      |
|           | Range            | 38 - 96      | 73 - 76      | 38 - 96   |
|           | SD               | 18.7         | -            | 16.2      |
| 1         | N                | 9            | 6            | 15        |
|           | $\bar{X}$ length | 101.9        | 97.8         | 100.3     |
|           | Range            | 86 - 111     | 95 - 101     | 86 - 111  |
|           | SD               | 8.3          | 2.1          | 6.7       |
| 2         | N                | 14           | 4            | 18        |
|           | $\bar{X}$ length | 127.4        | 125.3        | 126.9     |
|           | Range            | 116 - 147    | 107 - 150    | 107 - 150 |
|           | SD               | 9.2          | 19.1         | 12.4      |
| 3         | N                | 13           | 8            | 21        |
|           | $\bar{X}$ length | 138.5        | 140.6        | 139.3     |
|           | Range            | 120 - 155    | 127 - 159    | 120 - 159 |
|           | SD               | 9.5          | 10.9         | 9.8       |
| 4         | N                | 30           | 40           | 70        |
|           | $\bar{X}$ length | 157.4        | 157.4        | 157.8     |
|           | Range            | 139 - 180    | 137 - 174    | 137 - 180 |
|           | SD               | 8.3          | 10.6         | 9.6       |
| 5         | N                | 34           | 22           | 56        |
|           | $\bar{X}$ length | 167.1        | 162.9        | 165.5     |
|           | Range            | 147 - 190    | 146 - 186    | 146 - 190 |
|           | SD               | 12.6         | 10.0         | 11.7      |
| 6+        | N                | 9            | 13           | 22        |
|           | $\bar{X}$ length | 166.9        | 165.6        | 166.1     |
|           | Range            | 152 - 177    | 142 - 181    | 142 - 181 |
|           | SD               | 7.3          | 11.1         | 9.5       |

<sup>1/</sup> Length measurements in mm.

"658. Commercial Take of Frogs for Scientific or Educational Purposes.

"(a) Permit Required of Supplier. Permits shall be issued only to qualified scientific supply houses which sell frogs for scientific or educational purposes. Such supply houses shall be responsible for compliance by its employees with these regulations. The commission shall approve the qualifications of applicants under this section, and the department will issue the permit following approval by the commission.

"(b) Market Order Issued by Supplier. A qualified scientific supply house shall issue a market order to each employee before that employee collects frogs. Each market order shall specify the exact number of frogs to be collected, the collecting locality, and the dates, not to exceed seven (7) consecutive days, required for the employee to fill that order.

"(c) Licenses and Permits Required of Employees. Each employee who collects frogs for a qualified scientific supply house shall have a commercial fishing license and a scientific collecting permit issued by the department. Each boat used for this purpose shall be registered as a commercial fishing vessel.

"(d) Market Order in Possession of Employees. Each employee shall have a market order in his possession when frogs are being collected. No frogs in excess of the numbers specified on the market order may be taken or possessed by the employee of a qualified scientific supply house.

"(e) Commercial Fishing Reports Required. The provisions of Fish and Game Code shall apply to the taking of frogs for sale for scientific or educational purposes.

"(f) Closed Areas. No frogs may be taken for sale for scientific or educational purposes north of Highway 80 in the Valley Sportfishing District described in Section 16.00, Title 14, California Administrative Code.

"(g) Open Areas and Seasons. Frogs may be taken for sale for scientific or educational purposes only in the following sportfishing districts or parts thereof, and only during the specified dates:

- (1) Southern District as described in Section 4.00, Title 14, CAC - August 1 through November 30.
- (2) Colorado River District as described in Section 6.00, Title 14, CAC - August 1 through November 30.
- (3) Central Coast District as described in Section 7.50, Title 14, CAC - All Year.
- (4) Sierra District as described in Section 11.50, Title 14, CAC - All Year.
- (5) South of Highway 80 in the Valley District as described in Section 16.00, Title 14, CAC - May 1 through November 30.
- (6) North Coast District as described in Section 20.50, Title 14, CAC - All Year.
- (7) Delta District as described in Section 26.00, Title 14, CAC - May 1 through November 30.

"(h) Restricted Sale. Frogs taken under authority of a permit issued pursuant to this section may be used only for scientific or educational purposes, and may not be sold, purchased, or traded for any other use.

"(i) Delivery of Frogs. A licensed employee shall deliver or ship all captured frogs to the premises of the scientific supply house.

"(j) Frog Capture Methods. Frogs may be captured only by hand. No spears, gigs, hooks, or other devices which might injure frogs may be used.

"(k) Application Requirements. Permit applications shall be submitted on forms furnished by the department. They may be filed with the department at any time. Application for renewal of a permit for the following calendar year may be filed concurrently with the annual report in December.

"(l) Notification of Warden. Before collecting frogs, the supplier shall notify a warden in the area where the employee wishes to collect. Such notification may be given by letter, telephone, or personal contact and shall include the canals and exact location on each of entry and departure, the dates of collection, and approximate length of time during which collecting is to be done. The employee shall carry his commercial fishing license, scientific collecting permit and market order at all times when collecting. These documents and specimens shall be shown upon demand to any person authorized by the department to enforce the provisions of the California Fish and Game Code or regulation made pursuant thereto.

"(m) Cancellation and Suspension of Permits. Any permit may be cancelled or suspended at any time by the commission for cause after notice and opportunity to be heard, or without a hearing upon conviction of a violation of these regulations by a court of competent jurisdiction.

"The provisions of this section supersede Sections 6851, 6852, and 6854 of the Fish and Game Code."

Also, changes in the sport regulations were made on December 6, 1974, when the Fish and Game Commission approved the reduction of the daily sport bag and possession limit from 24 to 12 in the Valley and Delta sportfishing districts, and also established a sport season of April 1 through November 30 in the same two districts.

These changes, plus cooperation from the water suppliers and users, should in time restore bullfrog numbers. However, it is important that the populations in key canals be monitored to be sure that the resource is responding. If not, further revisions may be necessary.

#### LITERATURE CITED

- Brooks, G. R., Jr. 1964. An analysis of the food habits of the bullfrog, Rana catesbeiana, by body size, sex, month, and habitat. Virginia J. Sci. 15:173-186.
- Fulk, F. D. and J. O. Whitaker, Jr. 1968. The food of Rana catesbeiana in three habitats in Owen County, Indiana. Proc. Ind. Acad. Sci. 78:491-496.
- Korschgen, L. J. and T. S. Baskett. 1963. Foods of impoundment - and stream - dwelling bullfrogs in Missouri. Herpetologica 19(2):89-99.
- \_\_\_\_\_ and D. L. Moyle. 1955. Food habits of the bullfrog in central Missouri farm ponds. Amer. Midl. Nat. 54(2):332-341.
- Schroeder, E. E. and T. S. Baskett. 1968. Age estimations, growth rate, and population structure in Missouri bullfrogs. Copeia 1968:583-592.

Storer, T. I. 1922. The eastern bullfrog in California. Calif. Fish Game 8(4):219-224.

Treanor, R. R. 1975. Management of the bullfrog (Rana catesbeiana) resource in California. Calif. Dep. Fish and Game, Inland Fish. Admin. Rep. 75-1, 30 pp.

\_\_\_\_\_ and S. J. Nicola. 1972. A preliminary study of the commercial and sporting utilization of the bullfrog, Rana catesbeiana Shaw, in California. Calif. Dep. Fish and Game, Inland Fish. Admin. Rep. 72-4, 23 pp.