

FOOD HABITS OF THE RIVER OTTER IN SUISUN MARSH, CENTRAL CALIFORNIA

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Abstract.

The food habits of the river otter (*Lutra canadensis*) were studied in Suisun Marsh, Solano County, California. One hundred eighteen scats were analyzed by frequency of occurrence of food items for a one year period, and seasonal feeding patterns were determined. Major foods, in their order of importance, were crayfish, waterfowl, and fish. Crayfish consumption was high and constant throughout the year, but the take of fish and waterfowl varied according to season. Waterfowl consumption was proportional to waterfowl density. Some intake of plants was also noted.

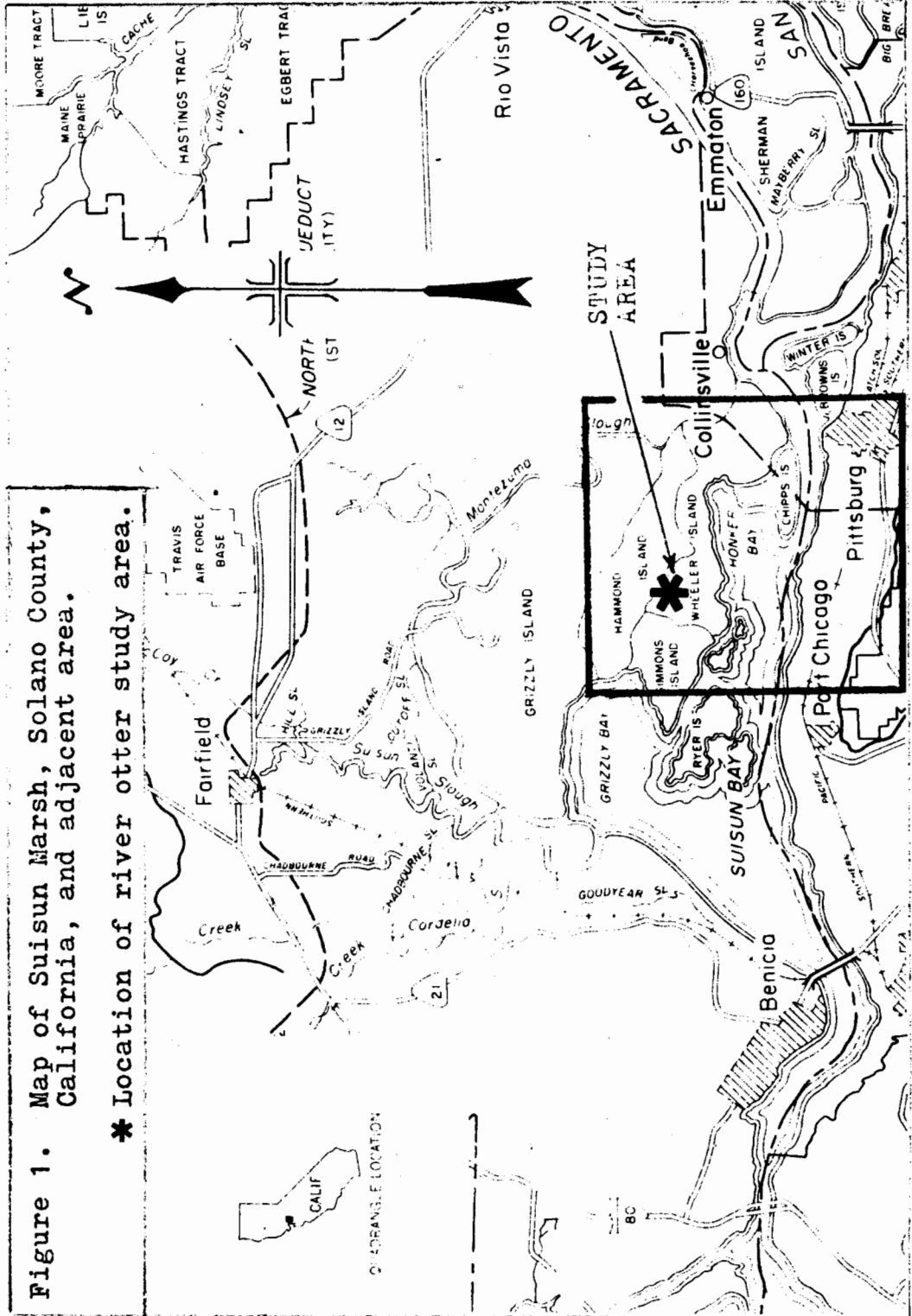
INTRODUCTION

Several river otter food habits studies have been conducted in different sections of the United States (Lagler and Ostenson 1942, Greer 1955, Ryder 1955, Hamilton 1961, Sheldon and Toll 1964, Knudsen and Hale 1968, Towiell 1974), but to date (1974) no such studies have been done in California. Most information on California river otters comes from Grinnell, Dixon and Linsdale (1937). Only two river otter food habits studies have been conducted in the western United States (Greer 1955, Toweill 1974). Considering the above, a food habits study of the California river otter is appropriate and timely.

The objective of this study was to determine the food items and seasonal feeding patterns of the river otter in Suisun Marsh, Solano County, California.

STUDY AREA

The investigation was conducted on Wheeler Island in Suisun Marsh, located in south-central Solano County, California (Figure 1). Suisun Marsh adjoins the extreme western tip of the Sacramento-San Joaquin Delta, and consists mainly of an intricate system of sloughs and channels separating land areas. The area contains approximately 54,000 acres of marshland, part of which is farmed, and 29,000 acres of water surface. The study area on Wheeler Island is not being farmed, but is controlled and managed by the Wheeler Island Duck Club for the expressed purpose of waterfowl shooting. Wheeler Island is bordered on the south by Honker Bay, on the west by Simmons Island and Mud Slough, on the north by Hammond Island and Roaring River Slough, and on the east by Van Sickle Island and Rock Creek. The elevation is at, or below, mean tide level except for levees that range from 6 to 8 feet above sea level. The exact location of the study area can be pinpointed on the U.S. Geological Survey (7.5 minute series) Honker Bay Quadrangle at the intersection of latitude $38^{\circ}05'40''N$ and longitude $122^{\circ}57'30''W$.



The dominant vegetation in the study area includes pickleweed (Salicornia pacifica), salt grass (Distichlis spicata), alkali bulrush (Scirpus robustus), roundstem tule (S. acutus), common cattail (Typha latifolia), Baltic rush (Juncus balticus), and California wild rose (Rosa californica). In general, the plants found in Suisun Marsh are a combination of those members of the coastal salt marsh and freshwater marsh plant communities listed by Munz and Keck (1968).

The winters in Suisun Marsh are mild and wet, and the summers are warm and dry. The rainy season generally starts in late October or November and continues into March. The annual average rainfall recorded over a 38 year period, at the town of Suisun, is 19.79 inches (50.27 cm). The prevailing winds are westerly. These cool moist winds blow inland from the Pacific Ocean and San Francisco Bay and temper what would otherwise be a hot summer climate typical of the Great Valley. Temperatures average 46° F during January and 72° F during July, the coolest and warmest month, respectively (Mall 1969).

Suisun Marsh is the largest single expanse of wetlands remaining in California and is of major importance as a wintering ground for migratory waterfowl of the Pacific Flyway. It is also unique in that it is less than one hour's drive from the Sacramento and San Francisco areas that support a combined population of about five million people.

Suisun Marsh was chosen as the study area because it probably supports one of the most concentrated river otter populations in the state. Otter sightings are commonplace by residents, hunters and fishermen.

METHODS AND MATERIALS

The method used for this study was scat analysis. A transect route was established by canoeing through the sloughs and channels of Wheeler Island in order to locate otter haul-out spots, rolling places, slides, and crossovers. Otter scats can usually be found nearby. The same transect was followed on each subsequent visit except for adjustments that were necessary because of winter flooding. During these periods of high water it was only possible to cover the general study area and search for scat locations above the water line.

The study began on 19 August 1972. At this time all scats collected were in various stages of drying and were all included in the summer sample. An attempt was made to clear the entire area of scats so that all scats gathered later could be dated more accurately. Twenty visits were made to the study area between 19 August 1972 and 26 June 1973. On each visit scats were collected and placed individually in plastic bags. When the transect was completed, scats were transferred to small brown paper bags so they could dry out thoroughly. Each bag was dated and stored until analysis could be made.

The California Department of Fish and Game provided the facilities of their food habits laboratory for the scat analysis. The author was also allowed to use their reference collections.

Dried otter scats were moistened prior to analysis. Each scat was placed in a clean quart jar half-filled with warm water. The jar was then sealed and shaken vigorously. The loosened contents were poured into a large sieve (14 squares per inch) and rinsed thoroughly. The remaining solid material was transferred to an enamelware tray and filled with $\frac{1}{2}$ inch of water so the contents could be spread evenly over the bottom. Dissecting forceps were used to sort the food items as they were viewed through a

dissecting microscope. Unknown items were placed in vials, capped, labelled, and stored until identification could be made. All unknowns, except bird feathers, were preserved in a 10 percent formalin solution. Feathers were dried and preserved with paradichlorobenzene crystals.

All food items were analyzed by their frequency of occurrence (Giles 1969). For example, if one scat was found to contain both bird and crayfish remains, regardless of the actual number of birds and crayfish that may have been involved, the records indicate one occurrence of each.

Mammal hairs were identified by comparing them with the Department of Fish and Game's reference collection and referring to "A Key to the Dorsal Guard Hairs of California Mammals" (Mayer 1952). Chandler's (1916) key to feather structure was used in conjunction with reference collections to aid in the identification of avian downy plumules. Both mammal hairs and bird feathers were examined with a compound microscope in the process of identification. Identification of fish, reptile and insect specimens was accomplished with help from experts in those respective fields. Most unknowns could only be keyed to family or genus.

RESULTS AND DISCUSSION

The most important food for river otters in Suisun Marsh is crayfish (Pacifasticus leniusculus). Crayfish remains were present in 98% of all scats examined (Table 1). Not only were crayfish the most important food item for the entire study, but for each season as well. The occurrence was never less than 95 percent, and during the winter and spring seasons it was 100 percent. Other food habits studies conducted by scat analysis do not show similar results. Sheldon and Toll (1964) found crayfish frequency of occurrence to be 46 percent in scats collected year around from central Massachusetts, and Knudsen and Hale (1968) found crayfish in only 28 percent of spring otter scats collected in Wisconsin. No crayfish remains were reported in any of the 1374 scats collected over a year's period by Greer (1955) in northwestern Montana. Lagler and Ostenson (1942) and Knudsen and Hale (1968) have studied the contents of river otter digestive tracts and have found that frequencies of occurrence for crayfish ranged between 42-55 percent and 17-59 percent, respectively. More recently Toweill (1974) found that crayfish were in 25 percent of the otter digestive tracts collected in western Oregon. Liers (1951) writes, "One of the most choice morsels is crayfish, and where they are abundant an otter will consume a tremendous number in a year's time". Apparently Suisun Marsh has a crayfish population capable of supplying the demand of the river otter.

Waterfowl were found to be the second most important food item in the river otter's diet. Bird remains, mostly feathers, were present in 38 percent of the scats analyzed (Table 1). Twenty-three scats contained duck feathers, all of which belonged to the genus Anas. Fourteen scats contained rail feathers. All but one of these were probably coot (Fulica americana) since all feathers were shades of gray and black. Large numbers of coots occur in Suisun Marsh during the winter. The feathers of the one remaining rail were reddish-brown and were probably that of Virginia rail (Rallus limicola).

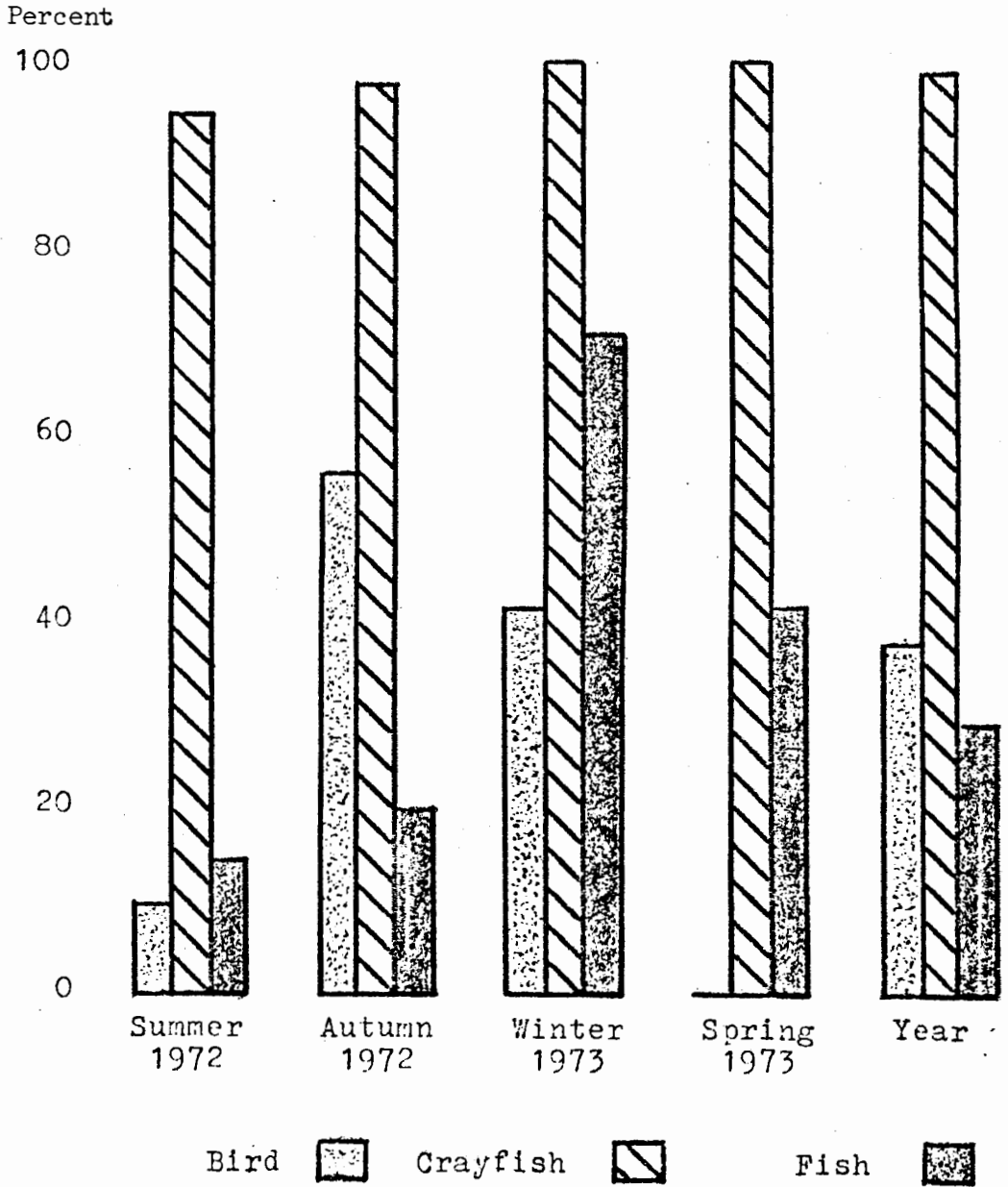
Waterfowl consumption by river otters was at its peak during autumn, then tapered off slightly during winter (Figure 2). This correlates directly with known waterfowl movements in Suisun Marsh. At first it was thought that waterfowl taken by otters were "cripples" resulting from duck hunting. However, waterfowl remains were evident in otter scats prior to the opening of duck season in mid-October 1972.

Table 1. Food items identified in 118 river otter scats collected in Suisun Marsh, Solano County, California.

Food Items	Number of scats					Year
	Summer-72	Autumn-72	Winter-73	Spring-73	118	
Plants	3 (14)*	4 (6)	8 (47)	15 (13)		
Wild Radish			8 (47)	8 (7)		
California Wild Rose	3 (14)	4 (6)		7 (6)		
Invertebrates	20 (95)	62 (98)	17 (100)	116 (98)		
Crayfish	20 (95)	62 (98)	17 (100)	116 (98)		
Water Scavenger Beetle	3 (14)	2 (3)	3 (18)	8 (7)		
Avian Louse		1 (2)		1 (1)		
Snail			1 (6)	1 (1)		
Unknown		4 (6)	2 (12)	6 (5)		
Fishes	3 (14)	13 (21)	12 (71)	7 (41)	35 (30)	
Reptiles		1 (2)		1 (1)		
Alligator Lizard		1 (2)		1 (1)		
Birds	2 (10)	36 (57)	7 (41)	45 (38)		
Duck	1 (5)	18 (29)	4 (24)	23 (19)		
Rail		12 (19)	2 (12)	14 (12)		
Meadowlark			1 (6)	1 (1)		
Unknown	1 (5)	9 (14)	1 (6)	11 (9)		
Mammals	1 (5)	6 (10)	1 (6)	8 (7)		
Deer Mouse	1 (5)	3 (5)	1 (6)	5 (4)		
Muskrat		1 (2)		1 (1)		
Rabbit		2 (3)		2 (2)		

* First figure is the number of scats in which each food item appeared. Bracketed figure is the percentage of scats in which each food item appeared.

Figure 2. Frequency of occurrence of the three major food items (crayfish, bird, and fish) used by river otters in Suisun Marsh, Solano County, California, showing seasonal patterns.



Suisun Marsh is not considered a significant waterfowl nesting area (George, Anderson and McKinnie 1965). Mallards (Anas platyrhynchos), gadwall (A. strepera), and cinnamon teal (A. cyanoptera) are the main species involved and nesting success is not very high (Anderson 1960). Even so, no egg fragments were found in any river otter scats. These findings compare with those of Dr. Dennis G. Raveling (1974, personal communication, Dept. of Wildlife and Fisheries Biology, University of California, Davis) in the James Bay muskeg in Canada. Dr. Raveling stated that there was a heavy population of river otters in that area, yet no goose nest predation could be attributed to them.

Previous otter scat analyses (Greer 1955, Sheldon and Toll 1964, Knudsen and Hale 1968) indicate that less than 5 percent of all otter scats examined contained bird remains. The results of this study differ markedly from the above. However, Suisun Marsh is an important wintering ground for waterfowl in the Pacific Flyway, and as the autumn season progresses, waterfowl numbers gradually increase until a peak population ranging between 500,000 and 700,000 birds is reached (George et al. 1965). Waterfowl concentrations of this magnitude must certainly provide a readily available food source for river otters.

Fish were found in 30 percent of the otter scats collected and ranked third in importance as food item (Table 1). Greer (1955), Sheldon and Toll (1964) and Knudsen and Hale (1968) all found fish to rank first in food item importance with frequencies of 93, 92, and 84 percent respectively. In this study, the consumption of fish increased as waterfowl consumption decreased (Figure 2). Since the decline in waterfowl consumption parallels migratory waterfowl departures from the Marsh, and since fish are present in the Marsh at all times, a preference for waterfowl is suggested. Waterfowl might be easier to catch or constitute a greater caloric return to the otter for the necessary energy expended.

Fish remains consisted mainly of vertebrae and scales, and further identification was not attempted. Thirty-three of the 35 fish samples contained large, opaque, cycloid scales, and one of these same samples contained molariform pharyngeal teeth. It is probable that all of these specimens belong to the family Cyprinidae. Of all the cyprinid fishes that are known to occur in Suisun Marsh, carp (Cyprinus carpio) and Sacramento squawfish (Ptychocheilus grandis) are the most likely possibilities (Caywood 1974, Personal communication, Dept. of Biology, California State University, Sacramento). The other two fish specimens contained ctenoid scales and palatine teeth. The most likely possibilities in this case are tule perch (Hysterocarpus traskii), striped bass (Morone saxatilis), or members of the sunfish family (Centrarchidae). Ninety-four percent of the fish eaten were nongame species.

Plants, mammals and reptiles ranked fourth, fifth, and sixth, respectively. Mammals were 7 percent in frequency of occurrence and probably were taken only as opportunity permitted. This closely compares to the findings of Greer (1955) and Sheldon and Toll (1964).

Wild rose seeds (Rosa californica) and pulp were found in seven scats and the stems and petals of wild radish (Raphanus sativus) were found in eight scats. Sheldon and Toll (1964) found that blueberries occurred in 28 percent of 226 summer scats collected in central Massachusetts.

Greer (1955) wrote that western painted turtles (Chrysemys picta) were abundant in his study area, but did not appear in any scats. The same is true for the western pond turtle (Clemmys marmorata) in Suisun Marsh. Thirty-two pond turtles were observed one morning as the author canoed about 1/2 mile (0.8 km) along Roaring

River Slough, yet no turtle remains were ever found in scats or in the marsh. Stophlett (1947) reported an incident in which a Florida river otter was observed dragging a large terrapin by one of its hind legs to a bank at the edge of a marsh. The otter was immediately joined by others, and together they proceeded to eat the terrapin.

Consumption of food items could be regarded as functions of availability, catchability and possibly palatability. In addition, river otters probably require more food just before and during winter. Crayfish consumption from season to season was not statistically different, and could have been the same throughout the year with bird and fish augmenting the diet during colder periods (Figure 2). The taking of birds was greatest when waterfowl density was at its peak. Fish consumption was the greatest during the winter when fish are usually less active and easier to catch.

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