CALIFORNIA FISH AND GAME

"CONSERVATION OF WILDLIFE THROUGH EDUCATION"

VOLUME 54 JANUARY 1968 NUMBER 1

California Fish and Game is a journal devoted to the conservation of wildlife. If its contents are reproduced elsewhere, the authors and the California Department of Fish and Game would appreciate being acknowledged.

The free mailing list is limited by budgetary considerations to persons who can make professional use of the material and to libraries, scientific institutions, and conservation agencies. Individuals must state their affiliation and position when submitting their applications. Subscriptions must be renewed annually by returning the postcard enclosed with each October issue. Subscribers are asked to report changes in address without delay.

Please direct correspondence, except regarding paid subscriptions, to:

LEO SHAPOVALOV, Editor
Department of Fish and Game
1416 9th Street
Sacramento, California 95814

Individuals and organizations who do not qualify for the free mailing list may subscribe at a rate of $2 per year or obtain individual issues for $0.75 per copy by placing their orders with the Office of Procurement, Documents Section, P.O. Box 20191, Sacramento, California 95820. Money orders or checks should be made out to Office of Procurement, Documents Section. Inquiries regarding paid subscriptions should be directed to the Office of Procurement.

CALIFORNIA FISH AND GAME

VOLUME 54 JANUARY 1968 NUMBER 1

Published Quarterly by
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

TABLE OF CONTENTS

Page

The Band-Tailed Pigeon in California ——— *Walton A. Smith* 4

A Summary of Band Recoveries from Redheads (*Aythya americana*) Banded in Northeastern California — *Warren C. Rienecker* 17

Determination of the Winter Range of a Black-Tailed Deer Herd in the North Coast Range of California ——— *Richard D. Bauer, Jerome T. Light, Jr., and William R. Thornton* 27

A Food Habits Study of the Southern Sea Otter, *Enhydra lutris nereis* ——— *Earl E. Ebert* 33

The Ability of Washington Anglers to Identify Some Common Marine Fishes ——— *Frank Haw and Raymond M. Buckley* 43

Two Fishes and a Mollusk, New to California's Marine Fauna, With Comments Regarding Other Recent Anomalous Occurrences *Alec R. Strachan, Charles H. Turner, and Charles T. Mitchell* 49

Book Reviews ——— 58

ERRATUM

Rosenblatt, Richard M., and Bernard J. Zahuranec. The eastern Pacific groupers of the genus *Mycteroperca*, including a new species. 53 (4) : 228–245, 1967.

Figure 3 on page 232 and Figure 4 on page 233 should be transposed. The captions for these figures should remain in place.

Calif. Fish and Game, 54 (1) : 4–16, 1968.

THE BAND-TAILED PIGEON IN CALIFORNIA[1]

WALTON A. SMITH
Wildlife Management Branch
California Department of Fish and Game

The Pacific band-tailed pigeon (*Columbia fasciata monilis*) follows two main migration routes as it enters California from the north. One route is along the Coast Range, and the second is along the western slopes of the Sierra Nevada. The fall southward migration is usually complete by October, and the spring migration is complete by the end of June. Resident pigeon populations mix freely with migrating flocks in the foothill and mountain areas of central coastal California during the fall.

A seasonal fluctuation in the diet of the pigeon was disclosed by the analysis of 157 pigeon crops and gizzards. The fall diet consisted primarily of mast, supplemented in the spring with cereal grains. Orchard fruit showed up heavily in the spring and summer diet. The berries and fruits from native trees and shrubs were important summer foods.

The salt content of water samples from two springs regularly visited by pigeons was 12,406 and 2,025 mg/liter. The ions most prevalent were calcium, sodium, chlorine, and sulfate.

Agricultural depredation on some crops by pigeons is recognized, and several methods of controlling damage to crops are discussed.

During the period 1952 to 1958, 3,084 pigeons were banded, from which only 170 bands were recovered. About two-thirds of the bands were recovered in California.

Destruction of habitat and hunting are the main factors limiting the band-tailed pigeon population.

Weights of adult pigeons varied from 340 to 470 g for males and 280 to 440 g for females.

INTRODUCTION

The Pacific band-tailed pigeon is one of the important migratory game birds in the Pacific Coast states. It is hunted in California and other western states. The mountain and foothill areas of the western states are the breeding range, and California is the primary wintering range.

The Pacific band-tail is usually restricted to the western side of the Sierra Nevada, and the Rocky Mountain subspecies is found in the mountain areas to the east of the Sierra Nevada. However, Paige (1964) reported the band-tailed pigeon from the Panamint Range of eastern California. H. T. Harper (pers. comm.) reported band-tailed pigeons from the Argus Range in Inyo County and from the eastern slopes of the Sierra Nevada near Little Lake, California. A.L. Hensley (pers. comm.) reported pigeons from the vicinity of Haiwee Reservoir, near Olancha, California, in Inyo County. There was no indication of the subspecies involved in any of these reports.

Since California is the principal wintering area of the band-tailed pigeon, it is imperative to gather data that will assist in the management of the species, insure the perpetuation of the species, and provide for hunter recreation when a surplus exists. It is estimated that by

[1] Submitted for publication March 1967. This study was made possible with funds of Federal Aid in Wildlife Restoration, California Project W-42-R, "Management Studies of Upland Game", and Project W-47-R, "Upland Game Investigations".

1980 there will be from 41,000 to 55,000 pigeon hunters and that the maximum annual bag will be 400,000 birds. This will approach the potential take allowable while maintaining the resource (California Fish and Wildlife Plan, 1966).

The primary objectives of this study were to determine: (i) migratory habits, (ii) food habits, (iii) population dynamics determined through trapping and banding, (iv) the effect of hunting on the population, and (v) the extent of depredations on agricultural crops.

This paper is a report on the results of the second part of a two-part study. The first report, on the nesting and reproduction of the band-tailed pigeon in California, was published earlier by Macgregor and Smith (1955).

METHODS AND MATERIALS

The migration routes and concentration areas were determined from band recovery data, observation, and personal interview of Department personnel.

Food habit information was obtained from field observation of feeding birds, field inspection of bird crops, and laboratory analysis of crop contents collected during the hunting season and from birds damaging agricultural crops.

Samples of water were collected from mineral springs near Bangor, Butte County, and French Gulch, Shasta County, and analyzed by department laboratory technicians to determine why these springs were used by pigeons.

To determine the population dynamics of the pigeon, trapping and banding operations were conducted throughout the year wherever pigeon concentrations were large enough to justify trapping effort. A sample of the breeding population was banded on the Monterey Peninsula, on the central coast of California. A segment of the migratory population wintering in California was also banded.

Several types of traps were used with varying degrees of success. A drop trap similar to the one described by Wooten (1955) was used with only limited success. A variation of the cannon-projected net trap described by Dill and Thornsberry (1950) was used successfully at mineral springs and in grain stubble fields. In areas where the cannon net trap could not be operated, a box-type trap with an opening in the top which could be closed manually by a sliding door of net was used successfully. The basic pattern of this trap was developed by technicians of the Colorado Game and Fish Commission (letter from Oregon State Game Commission).

All captured birds were banded with No. 5 aluminum bands supplied by the U. S. Fish and Wildlife Service. Some birds were color marked successfully with a picric acid and alcohol solution.

The most acceptable trap bait for band-tailed pigeons was whatever the birds happened to be feeding on at the time. In the Carmel area various grains such as milo, cracked corn, and whole barley were used with good success. During the summer, after the barley fields had been harvested, barley was acceptable. Attempts to bait with food other than what was naturally available to the birds were usually unsuccessful.

Plumage characteristics were used to determine the sex and age of the trapped birds. The plumage characteristics used in sexing and

aging the birds were the intense pinkish brown on the breast of the male, which extends farther along the breast and flanks than in the female, and the more extensive and brighter bronze-green iridescence on the neck of the male. Juveniles were separated by the pale edging on the wing coverts, lack of a distinct neck crescent, and general lack of adult coloration.

As a check on the ability of an observer to determine the sex and age of pigeons, the birds in the hunter's bag were also inspected internally for sex characteristics. Age was determined by the presence of the bursa of Fabricius in immature birds. The hunter kill data were obtained by checking hunters leaving the hunting areas and recording the hunter success.

A dynamic life table was constructed from band recovery data for band-tailed pigeons to determine the annual mortality rate (method of Hickey, 1952).

RESULTS

Migration

It is difficult to predict the route of travel or the time of arrival of migratory pigeons wintering in California. There are two main migration routes for birds coming from the north. One route is along the Klamath Mountains and Cascade Range in north central California and south along the Coast Ranges in the western part of California; the second route is from the Cascade Range south along the western slopes of the Sierra Nevada in central California to the Tehachapi Mountains in south-central California and continuing into southern California ranges. One route may be used one year to the complete exclusion of the other. Periodically there is a shift from one side to the other of the interior valleys. A flock of pigeons was observed crossing the Sacramento Valley near the Sutter Buttes by Wallace Macgregor in 1954, and large flights of pigeons were reported crossing the San Joaquin Valley near Reedley during the fall of 1951 (State Game Warden G. Davis, pers. comm.). Neff (1947) reports an observation by R. J. Little of 9,000 pigeons stopping to feed in the Sutter Buttes, a small mountain range in the center of the Sacramento Valley, on February 20, 1935. Neff also reports seeing two migrating bands of pigeons flying across the Sacramento Valley in May, 1932.

The time of arrival of migrating pigeons in California varies from year to year. Usually by late September the majority of the birds from the northern coastal states have arrived in California and by mid-October are entirely within the State.

The time required to complete the southward migration depends largely upon the availability of food along the migration route. During years when there is a scarcity of food in northern California, the southward migration is completed earlier than usual.

The northward migration is usually complete by the first of April, and very few large pigeon concentrations can be found in central and southern California after April. Glover (1953) gives the last week of March as the arrival time of spring migrants in the Humboldt Bay area. There the migration was at its peak in April and continued through June. During this study it was discovered that not all pigeons

migrated. Nonmigratory flocks of band-tailed pigeons were found in the Monterey Peninsula area and in the foothills near Pasadena in southern California. Migratory flocks often visited areas where resident pigeons were present.

Band recoveries indicate that summer resident pigeons often join fall migrating flocks to feed in foothill and mountain areas. Color marked birds, banded during the summer on the Monterey Peninsula, were frequently observed with large migratory flocks feeding in the barley stubble fields near Carmel Valley, near Carmel on the Monterey Peninsula, during the fall. At least six banded and color marked birds were killed by hunters in the Santa Lucia Mountains, Monterey County; one was banded as a nestling during the summer at Carmel. Of the birds banded during the months of June, July, and August on the Monterey Peninsula and in Carmel Valley and recovered during the hunting seasons, none was recovered over 2 miles north from the banding stations.

Food Habits

The feeding habits are unique in that the birds are highly mobile and are able to locate food concentration areas readily. Traditional feeding areas may not be frequented if food shortages exist. Also, rather large items are taken, considering the size of the birds. Whole acorns and fruits are taken from trees by an assortment of acrobatic maneuvers, especially during the fall and winter. The birds often cling precariously to small branches to obtain acorns and fruits, then drop to a lower branch and continue the search for food. When searching for acorns in the forest duff, the leaves and debris are flipped aside by a horizontal movement of the beak. In grain stubble, pigeons feed in a compact group and advance by alternately walking and flying to the front of the advancing flock.

Feeding is usually restricted to one abundant food item, even though other food may be readily available. When food is limited, however, pigeons often resort to a variety of food items. Recognizable quantities of material from five different plant species were found in a single crop examined on July 22, 1953, which contained barley, blackberries, huckleberries, manzanita berries (*Arctostaphylos* sp.), and immature acorns.

If allowed to feed undisturbed, pigeons may gorge themselves to the extent of impeding normal flight. Some examples of the quantity of food items eaten by individual pigeons are 42 acorns (H. M. Worcester, 1951, pers. comm.), 111 madrone berries (H. M. Worcester, 1951, pers. comm.), 80 dogwood fruits (Neff, 1947), 104 cascara berries (Neff, 1947), 879 wheat kernels (C. H. Lostetter, 1959, pers. comm.), 615 barley seeds (Gilman, 1903), and 97 green apricots.

Crop and Stomach Analysis

The samples of food habits data available are limited and scattered over a long time period and over a wide area of California. Samples of food habits material collected over an 8-month period indicate a definite seasonal pattern in the feeding habits of the pigeon (Table 1).

Mast food items, mostly acorns, are used heavily in the fall, winter, and on into the spring, being supplemented by cereal grains, primarily

TABLE 1

Food Eaten by 157 Band-Tailed Pigeons—Crop and Gizzard Analysis
Statewide, 1949–1958

Item	February (52)		March (1)		April (11)		May (4)		July (15)		September (31)		November (13)		December (27)		Total (157)	
	Vol %	Freq	Vol %	Freq	Vol %	Freq	Vol %	Freq	Vol %	Freq	Vol %	Freq	Vol %	Freq	Vol %	Freq	Vol %	Freq
CULTIVATED FOODS																		
Wheat (*Triticum aestivum*)	63.8	36	--	--	--	--	--	--	--	--	-	-	-	-	--	--	21.1	36
Barley (*Hordeum vulgare*)	33.8	43	--	--	9.1	2	--	--	90.5	15	-	-	-	-	--	--	20.8	60
Apricot (*Prunus armeniaca*)	--	--	--	--	--	--	73.2	4	--	--	-	-	-	-	-	-	1.9	4
Corn (*Zea mays*)	--	--	--	--	18.2	2	--	--	-	-	-	-	-	-	-	-	1.3	2
Olive (*Olea europaea*)	--	--	--	--	--	-	26.8	2	-	-	-	-	-	-	-	-	0.7	2
Oats (*Avena sativa*)	0.3	3	--	--	--	-	--	-	-	-	-	-	-	-	-	-	0.1	3
MAST																		
Acorns (*Quercus* sp.)	2.1	8	25.0	1	72.7	8	--	--	-	-	-	-	-	-	32.0	9	11.7	26
Coast live oak (*Q. agrifolia*)	--	--	75.0	3	--	--	--	--	-	-	9.6	3	69.2	9	48.8	13	17.9	28
Black Oak (*Q. kelloggii*)	--	--	--	--	--	--	--	--	-	-	3.2	1	7.7	1	-	--	1.3	2
Scrub oak (*Q. dumosa*)	--	--	--	--	--	--	--	--	-	-	-	-	-	-	7.4	2	1.3	2
Blue oak (*Q. douglasii*)	--	--	--	--	--	-	--	--	--	-	-	-	5.8	1	--	--	0.5	1
Oak catkins	--	--	--	--	--	--	--	--	-	-	-	-	--	--	0.4	5	0.1	5
SHRUBS																		
Dogwood (*Cornus nuttallii*)	--	--	--	--	--	--	--	--	--	--	35.4	12	--	--	--	--	7.0	12
Coffeeberry (*Rhamnus californica*)	--	--	--	--	--	--	--	--	--	--	21.3	10	--	--	--	-	1.8	10
Madrone (*Arbutus menziesii*)	--	--	--	--	--	--	--	--	--	--	-	-	17.3	3	11.1	5	3.1	8
Cascara (*R. purshiana*)	--	--	--	--	--	--	--	--	--	--	6.5	2	--	--	--	--	1.3	2
Styrax (*Styrax officinalis*)	--	--	--	--	--	--	--	--	--	--	11.3	4	--	--	--	--	2.2	1
Wild grape (*Vitis californica*)	--	--	--	--	--	--	--	--	--	--	6.5	2	--	--	--	--	1.3	2
Elderberry (*Sambucus glauca*)	--	--	--	--	--	--	--	--	--	--	3.2	1	--	-	--	--	0.6	1
Gooseberry (*Ribes* sp.)	--	--	--	--	--	--	--	--	3.3	1	--	-	--	-	--	--	0.3	1
Huckleberry (*Vaccinium ovatum*)	--	--	--	--	--	--	--	--	0.5	1	--	--	--	--	--	--	tr	1
Blackberry (*Rubus vitifolia*)	--	--	--	--	--	--	--	--	0.1	1	--	--	--	--	--	--	tr	1
WEEDS																		
Forb stems	--	--	--	--	tr	1	--	--	--	--	--	--	--	--	--	-	tr	1
Milk thistle (*Silybum marianum*)	--	--	--	--	--	--	--	--	2.5	1	--	--	--	--	--	--	0.2	1
GRASS																		
Grass leafage (Gramineae)	--	--	--	--	tr	1	--	--	--	--	--	--	--	-	--	-	tr	1
ANIMAL FOOD																		
Insect fragments	--	--	--	--	tr	1	--	--	--	--	-	-	-	-	-	-	tr	1
Ant fragments (Formicidae)	--	--	--	--	--	--	--	--	--	--	tr	1	--	--	--	-	tr	1
Insect galls	--	--	--	--	--	--	--	--	3.1	1	--	--	--	--	--	--	0.2	2

waste grain from harvest operations. Orchard fruit shows up in the spring food habits sample; however, it must be pointed out that those stomach samples containing orchard fruit were obtained while investigating depredation complaints. Some of the crops examined during the month of February contained cereal grains and were noted in collections made on depredation investigations.

The berries and fruits from native trees and shrubs become important in the diet as the summer progresses.

Data from other western states (Neff, 1947) show a similar pattern but add piñon pine (*Pinus cembroides*) nuts to the mast of fall and winter foods. The absence of pine nuts in the California data reflects the meager sampling. Few pigeon hunters in the Frazier Mountain-Mt. Pinos region of Kern County fail to recognize the significance of a good piñon pine mast crop in relation to their hunting success.

Field analysis from sources other than those analyzed in the department laboratory also document the significance of cultivated crops in the pigeon diet during years of severe winters and failure of natural food supplies. W. L. Farschon (1949, pers. comm.) found barley, oats, raisins (*Vitus* sp.), and almond buds (*Prunus* sp.) in the crops of 18 pigeons examined in Fresno County during March and black walnut (*Juglans* sp.) buds and olives during April. R. Henry (1949, pers. comm.) found olives, barley, oats, and mistletoe (*Phoradendron* sp.) berries in the crops of 14 birds examined during April 1949 near Fresno.

Grit

Gravel or grit in the gizzard is required for grinding most of the food eaten by band-tailed pigeons. Of the gizzards examined by the department laboratory, 29 contained 36.8 cc of grit, an average of 1.3 cc per gizzard, which was 19.5% of the total gizzard contents. The ratio of grit to the total crop and stomach contents of 639 crops and stomachs reported by Neff (1947) ranged from 7.5% in July to 31.4% in December and averaged 18.4%. Neff also found that grit was utilized by the birds every month of the year but in lesser amounts in gizzards containing hard fruit pits.

Water

Water is required daily and is usually taken at midmorning and in late afternoon. Drinking is accomplished by dipping the bill into the water and swallowing without raising the head. Fresh water in shallow basins is used for bathing.

Mineral water is eagerly sought by pigeons during the early fall and winter. This apparent craving for mineral salts is well known, and certain springs are famous concentration areas. Seawater is also used in California and Washington.

The analysis of the water samples from French Gulch Spring, Shasta County, and Bangor Spring, Butte County, which were heavily used, is as follows: conductivity (mhos/cm) 21.0 and 4.5, respectively; total salts 12,406 mg/liter and 2,025 mg/liter, respectively. The mineral content of the springs in mg/liter were: calcium, 1,140 and 57; magnesium, 7 and 18; sodium, 3,505 and 936; chlorine, 6,635 and 492; sulfate, 1,074 and 230; and bicarbonate, 45 and 292. The total salinity of French

Gulch Spring is over six times that of Bangor Spring. However, the water analyses do not yield a clue to why pigeons prefer these waters. The possibility is that the craving for some specific ion is related to some physiological function, such as the digestion of mast.

Relationship to Agriculture

The relationship of band-tailed pigeons to agricultural operations in California has a long and controversial history, dating back to at least 1900. Damage to crops, real or alleged, causes concern to agriculturists and to state and federal game agencies charged with maintaining and protecting the pigeon population.

Most crop damage complaints occur in late winter (February), spring, and early summer (June), at which time the staple food items become scarce. At this time the pigeons utilize the fruit and seeds of cultivated crops, as well as buds and flowers of native plants. During fall and winter, cereal grains are sought from stubble fields. In late winter and early spring, seeded grains are utilized. Late spring and early summer often find the birds in the valley areas picking buds and immature fruit from plum, prune, apricot, peach, and almond orchards.

Band-tailed pigeons may damage orchards and vineyards extensively, often causing considerable financial loss by their destruction of fruit and fruit buds, and breakage of sprouts, shoots, branches, and vines.

Most complaints of damage to seeded or sprouted grain must be discounted because band-tailed pigeons do not dig or scratch, nor do they pull sprouted grain. Examination of the crop contents of birds collected in sprouted grain fields revealed that only dry, exposed, and unsprouted grain was eaten. Usually some extra seed that is not covered by the planting operation is available.

Methods of Crop Protection

Appeals for relief from crop depredations usually come to the attention of the law enforcement or management branches of the California Department of Fish and Game, who in turn notify the U. S. Fish and Wildlife Service management agent concerned. The usual procedure is for representatives of the state and federal agencies to investigate the complaint and attempt to devise an efficient and economical method for prevention or alleviation of damage.

The first attempts to prevent crop damage by pigeons were by killing or herding the birds by gunfire. However, these methods brought about public criticism, especially when the birds were killed. Herding, under strict control, is more desirable. Rope firecrackers and shell crackers were used effectively for dispersing band-tailed pigeons from apricot orchards in Hemet Valley, Riverside County, during the spring of 1958. The use of such devices is described by Mosby (1963).

Other Complaints

Occasionally pigeons are accused of spreading disease. In April 1952 an olive grower near Corning complained that pigeons migrating from southern California were spreading olive scale to his trees. Investigation revealed that olive scale is motile only during late summer, and there is no possibility of spreading the disease during spring. Again in April 1954, an outbreak of erysipelas in domestic turkeys near Groveland was

attributed to band-tailed pigeons visiting the feed trough. A check of the area revealed that hogs were kept in a pen adjacent to a turkey pen, and since hogs are the most important host of the disease it seemed probable that they were the source of the infection. Cunningham (1916) reports that stockmen in the vicinity of Sequoia National Park believed that wild pigeons carried hog cholera from the upper San Joaquin Valley and infected their hogs. There was no evidence to support this contention.

Trapping and Banding

Before 1952, only 654 band-tailed pigeons had been banded in all of the West Coast states, including 243 in California. From 1952 to 1958, 3,084 pigeons were banded by the California Department of Fish and Game and the U.S. Fish and Wildlife Service. From 15 banding stations, 408 pigeons were banded in 1952, 1,391 in 1953, 848 in 1954, 314 in 1955, and 123 from 1956 to 1958. During the banding period, 1,545 birds were banded on the Monterey Peninsula.

During this banding period, 1,814 pigeons were sexed and aged. There were 1,561 adults (716 males, 822 females, and 23 not sexed). The immatures totaled 253. The immature to adult ratio was 16:100, and the adult male to adult female ratio was 87:100. The immature to adult ratio seems quite low in view of the higher ratios obtained during the hunter bag checks (46 immatures:100 adults). It seems probable that the adult segment of the population that was banded after the hunting season and before the nesting season weighted the immature:adult ratio toward the adult side. Also, the banding operations extended throughout the year, and sexing and aging by plumage characteristics were performed more accurately during the breeding season. An error of at least 10% is recognized in sexing.

Band Recovery

Only 170 bands were recovered from the 3,084 pigeons banded in California from 1952 to 1958, a recovery rate of 5.5%. This rate of band recovery is very low in comparison with rates of 30% or more in waterfowl and other game birds. Most of the total band recoveries were from within California, 113 (66.5%). Most of these birds, 67 (59.8%), were recovered from Monterey County. For Oregon, Washington, and British Columbia, the number and percentage of recoveries were 28 (16.5%), 20 (11.7%), and 9 (5.3%), respectively.

From birds banded in Oregon and Washington from 1952 to 1958, 106 bands were recovered in California, 89 from Oregon and 17 from Washington. One of the birds banded in British Columbia in 1955 was recovered in California. It is of interest to note that 27 (25.2%) of these birds were recovered in Monterey County.

The total number and percentage recovery of bands recovered each year after banding was 61 (38.2%) the 1st year, 38 (22.4%) the 2nd year, 31 (18.2%) the 3rd year, 16 (9.4%) the 4th year, and 20 (11.8%) the 5th year and after. Bands recovered from hunters totaled 145 and represented 84.7% of the total band recovery.

Eleven bands were recovered the 5th year after banding. The longest period of time from banding to recovery was 9 years 5 months and 7 days; another band was recovered in 9 years 3 months and 10 days.

Hickey (1952) and others used band recovery data to estimate avian mortality based upon the inference that the annual rate of band recovery is representative of the annual mortality of a population. Construction of a mortality table from data in this study results in a first year mortality of 38.2% and an average annual rate of 42.7% for birds of all age classes.

Nonhunting Mortality

The natural decimating factors affecting band-tailed pigeon populations are not well known. Edminister (1954) lists predation, disease, parasites, and accidents as mortality factors.

There are few records of predation on band-tails. Willard (1916) mentions that prairie falcons and Cooper's hawks took a considerable toll from flocks in Arizona. Clarence Cottam in a letter reported by Neff (1947) stated that a "specimen was struck from a flock by a sharp-shinned hawk". F. C. Edminister (1954 letter from J. A. Neff) says "the goshawk is potentially the worst pigeon predator in Colorado".

Harassment of band-tails by predators is probably much greater than actual predation. McLean (1925) observed a western goshawk pursue band-tails in Yosemite National Park. McLean also reported (pers. comm.) that on November 14, 1944, he saw a goshawk catch a pigeon from a flock leaving a water hole near Montgomery Creek, Shasta County. A Cooper's hawk was observed diving at a flock of about 25 pigeons perched in a dead tree in Monterey County. The pigeons dropped away toward the ground and easily evaded the attack.

Band-tailed pigeons are probably most vulnerable to predation during the nesting season. E. A. Kitchin (Bent, 1932) noted that in Washington on more than one occasion a gray squirrel had taken possession of a pigeon nest to use as a foundation for its own nest. He said that apparently the gray squirrel was the only enemy these birds had during the breeding season. Maegregor and Smith (1955), in reporting on the fate of unsuccessful nests on the Monterey Peninsula, cited two instances of predation by jays and ravens, and one case of failure caused by human interference.

On several occasions sick and dying pigeons have been reported in California. Rarely have such reports been received soon enough for investigation. At a ranch east of Gonzales visited in March 1953, about 200 pigeon carcasses were found. An eye witness said that before the birds died "they would become weak and flightless and flop around on the ground". The witness caught some birds and saw a black looking liquid dripping from their beaks and their mouths appeared black. Twelve carcasses sent to the department laboratory showed no significant pathological symptoms. Poison was suspected, but a positive diagnosis could not be made.

No evidence of disease or parasites was detected in the blood and fecal samples from 70 pigeons trapped during March 1953 near Bangor, Butte County.

A report by Neff (1947) mentions sick pigeons taken in Washington. Upon examination, no evidence of poison or bacterial disease was found.

No mention is made in the literature of specific diseases causing losses to pigeons. Neff (1947) found 12 flatworms in the abdominal cavity of a Colorado specimen. A specimen of the nematode *Ascarida columbae* was discovered in the connective tissue of a bird collected in California on September 16, 1952, near the upper Van Duzen River (M. N. Rosen, 1959, pers. comm.). A bird collected near Bangor, California, was parasitized by nematodes. Of 109 pigeons in Colorado examined by Robert M. Stabler (Neff, 1952), 21 (19.3%) reacted positively to trichomoniasis (*Trichomonas gallinae*). Trichomoniasis was found in a dead pigeon from Shasta County in March 1967, but no large-scale die-off was reported.

Accidental death due to collisions with various obstacles occurs periodically. One young bird was killed by flying into a picture window in the Carmel area.

From the available evidence it is difficult to assign predation, disease, parasites, and accidents as major mortality factors. The theory that populations with a low breeding potential usually have a low death rate appears to apply to the band-tail. Man, through destruction of habitat and hunting, is the main factor in limiting band-tailed pigeon populations.

Hunting

History

Before the early part of the 20th Century, hunting for band-tails was spread over a long period, with unrestricted bag limits and hunting methods. Hunting for sport was limited to the few hunters residing near one of the fall concentration areas. Although some market hunters took band-tails along with other game, their activities did not seriously affect the pigeon populations. The erratic distribution and the inaccessible habitat of the band-tails, together with poor transportation facilities for the hunters, served effectively to prevent overharvesting until 1911.

Indiscriminate shooting of large numbers of pigeons occurred when birds were thought to be damaging planted grain near Paso Robles during the fall and winter of 1911–1912. This aroused conservationists, and Joseph Grinnell was commissioned by the California Fish and Game Commission to appraise the status of the band-tailed pigeon. Soon after Grinnell (1913) recommended that a closed season was advisable, the band-tailed pigeon was included in the provisions of the Migratory Bird Act of 1913. This act directed the U.S. Fish and Wildlife Service to adopt protective regulations for both game and nongame birds. The 5-year closed season, authorized by the Migratory Bird Law of 1913, was extended another 12 years by the Migratory Bird Treaty Act of 1918.

During this period of total protection, band-tailed pigeons increased rapidly, and by 1924 crop damage complaints became so numerous that permits authorizing the killing of pigeons causing damage were issued by the U.S. Fish and Wildlife Service.

The first open season since 1913 was permitted in California in 1932. This season, from December 1 through the 15, with a bag limit of 10 birds, remained in effect until 1945. In 1946 the season was

lengthened to 30 days (September 1 through September 30). In 1947 the season was moved back to December. The first split season was inaugurated in 1948: from September 16–30 in the northern counties and December 17–31 in the balance of the State. A split season, with changes in the counties included, has been continued to the present time. The bag limit was reduced to eight birds in 1950 and six in 1951, and was restored to eight birds (the present limit) in 1960.

The opening date of the first half of the 1953 season was moved to October 16 because of data obtained in a hunter bag check in 1952. It was found that milk glands were present in various stages of activity in 60% of the adult birds checked, indicating that a large percentage of them were still caring for young in September.

Hunting Kill

From 1951 through 1955, 12,637 hunters, with a total bag of 26,937 pigeons, were checked through checking stations. The average bag was 2.1 birds per hunter. The success ratio of birds per hunter from 1951 through 1955 was 3.9, 2.0, 3.3, 2.0, and 4.1 birds per hunter, respectively.

The hunter success ratio obtained from the annual questionnaire survey of a 2% sample of the licensed hunters who reported hunting pigeons in 1954 and 1955 was 2.2 and 3.9 birds per hunter, and the success ratio from the hunter bag checks was 2.0 and 4.1 birds per hunter. Comparable data were available only for the years 1954 and 1955. The similarity of results for 1954 and 1955 suggests that the hunter success as indicated by the annual hunter questionnaire may be valid for determining trends in pigeon populations. Morse (1951), in attempting to correlate preseason census data and data from hunter bag checks near Nehalam Bay, Oregon, found that data obtained by census approximated data from hunter bag checks, indicating that an increase in pigeon numbers is usually reflected in a higher hunter success ratio.

Sex-Age Ratio

The ratio of males to females obtained from hunter bag checks averaged 110 males per 100 females over the 5-year period from 1951 through 1955. The sex ratios for this period ranged from 80 males per 100 females in 1952 to 146 males per 100 females in 1953.

The age ratios of fall-killed birds ranged from 110 juveniles per 100 adults (small sample in 1951) to 46 per 100 in 1955. The 5-year average young-adult ratio of all birds checked was 59:100. Edminister (1954) gives the fall age ratios of hunter-killed birds in Oregon as 0.33:1 young per adult in 1949, 1950, and 1951; 0.29:1 in 1952; and 0.26:1 in 1953. The discrepancies in age ratios of band-tails in Oregon and California are difficult to explain unless a differential migration or kill of one age class occurred.

By visually checking the plumage characteristics of 230 adults in the hunter's bag, sexes could be determined with 90% accuracy, and the success of visually aging 321 adult and immature birds by plumage characteristics was 96%. Attempts to determine the sex of 54 immature pigeons was accomplished with only 63% accuracy. The results of these visual attempts to determine the sex of adult band-tailed

pigeons from plumage characteristics agree substantially with the studies by Neff and Culbreath (1947) in Colorado, in which the appraisals of sex were approximately 90% correct.

Weight

The average weight of 74 adult males and 76 adult females was 415 and 390 g, respectively. The weights varied from 340 to 470 g for males and 280 to 440 g for females.

For 50 immature males and 57 immature females, the average weights were 391 and 364 g, respectively. The weights varied from 300 to 460 g for immature males and 270 to 420 g for immature females.

The average weight of 17 adult pigeons shot in Colorado and reported by Neff (1952) was 338 g, 52 g less than the average weight of adult females obtained in the present study in California.

Drewien et al. (1966) reported the average weight of 386 band-tails trapped at Humboldt State College during the spring of 1966 to be 404 g for adult males and 386 g for adult females. These birds averaged slightly less than the average weights for adults recorded during the present study.

The heaviest bird weighed, as reported by Drewien et al. (1966), was 40 g more than the heaviest bird recorded in California studies.

DISCUSSION

The erratic nature of the migration of the band-tailed pigeon makes a population inventory very difficult. Methods attempted were a post-hunting season and a postbreeding season survey and an aerial survey.

The resident population, which breeds in California, joins migrating flocks from the north and moves to the mountains during the fall.

Seventeen birds banded during the breeding season were shot during the same year from large migratory flocks. Of the birds visiting the Carmel area and banded between February and May of the annual banding periods, 16 were recovered out-of-State.

Depredation by pigeons is a real threat to some crops in California. Almonds, walnuts, apricots, cherries, bush berries, and olives are all subject to crop loss occasionally. Most grain taken by pigeons is that wasted while being harvested or left uncovered in the planting operations. The large mobile flocks of pigeons feeding in orchards or newly planted grain fields do cause real concern to ranchers.

Band recoveries indicate the wide distribution of the band-tailed pigeon on the Pacific Coast, as well as mortality and longevity. That part of the total mortality represented by band recoveries, irrespective of hunting kill, was 15.3% of the total bands recovered.

The fact that hunting is responsible for such a large percentage of the total mortality indicates that hunting controls as a management tool are invaluable.

A preseason census along the Pacific Coast from British Columbia to California would be invaluable in predicting trends of the populations. This was indicated by data from this study and that of Morse (1951).

ACKNOWLEDGMENTS

The author wishes to express appreciation to the members of the Wildlife Management Branch of the California Department of Fish and Game who diligently reported the number and location of band-tailed pigeons observed during their regular tour of duty, and to members of the Wildlife Protection Branch who assisted in amassing hunter kill data and pertinent observations.

The author is sincerely appreciative to the many residents of Carmel and the Monterey Peninsula who permitted access to their properties for trapping and observation; in this respect, Laidlaw Williams and the late L. R. Myler were especially helpful.

Special acknowledgment is given to Donald D. McLean, former Upland Game Project Supervisor, and Wallace G. Macgregor, former project leader, for their assistance in planning the study and contributing to the accumulation of field data, and to Bruce Browning for his assistance in interpretation of the food habits data.

For critically reading the manuscript, the author is grateful to Robert D. Mallette, project field supervisor, Otton Bauer, and William Anderson.

REFERENCES

Bent, Arthur C. 1932. Life histories of North American gallinaceous birds. U.S. Natl. Mus. Bull., (162) : 490 p.

Cunningham, F. P. 1916. Wild pigeons accused of carrying hog cholera. Calif. Fish and Game, 2 (4) : 214.

Dill, H. H., and W. H. Thornsberry. 1950. A cannon-projected net trap for capturing waterfowl. Jour. Wildl. Mangt., 14 (2) : 132–137.

Drewien, Roderick C., Richard J. Vernimen, Stanley W. Harris, and Charles F. Yocum. 1966. Spring weights of band-tailed pigeons. Jour. Wildl. Mangt., 30 (1) : 190–192.

Edminister, Frank C. 1954. American game birds of field and forest, their habits, ecology and management. Charles Scribner's Sons, New York. 490 p.

Gilman, Marshall F. 1903. More about the band-tailed pigeon *(Columba fasciata)*. Condor, (5) : 134–135.

Glover, Fred A. 1953. A nesting study of the band-tailed pigeon *(Columba f. fasciata)* in northwestern California. Calif. Fish and Game, 39 (3) : 397–407.

Grinnell, Joseph. 1913. The outlook for conserving the band-tailed pigeon as a game bird of California. Condor, (15) : 25–40.

Hickey, Joseph J. 1952. Survival studies of banded birds. U. S. Fish and Wildl. Serv., Spec. Sci. Rept.: Wildl., (15) : 177 p.

Macgregor, Wallace G., and W. M. Smith. 1955. Nesting and reproduction of the band-tailed pigeon in California. Calif. Fish and Game, 41 (4) : 315–326.

McLean, Donald D. 1925. A western goshawk scatters Yosemite's band-tailed pigeon colony. Yosemite Nature Notes 4 : 103.

Morse, William B. 1951. Special report band-tailed pigeon season. Oregon State Game Comm., 7 p.

Mosby, Henry S. [ed.]. 1963. Wildlife investigational techniques (2nd ed.). Wildl. Soc., xxiv + 419 p.

Neff, Johnson A. 1947. Habits, food, and economic status of the band-tailed pigeon. North American Fauna 58, 76 p.

— 1952. Inventory of band-tailed pigeon populations in Arizona, Colorado, and New Mexico. U.S. Fish and Wildl. Serv., Denver Wildl. Res. Lab., 26 p. (Mimeo.)

Neff, Johnson A., and J. C. Culbreath. 1947. Status of the band-tailed pigeon in Colorado season of 1946. Colorado Game and Fish Dept., 24 p.

Paige, Bruce B. 1964. The band-tailed pigeon in the Panamint Range of California. Condor, 66 (5) : 439.

Willard, Frances C. 1916. Nesting of the band-tailed pigeon in southern Arizona. Condor, (18) : 110–112.

Wooten, William A. 1955. A trapping technique for band-tailed pigeons. Jour. Wildl. Mangt., 19 (3) : 411–112.

Calif. Fish and Game, 54 (1) : 17–26. 1968.

A SUMMARY OF BAND RECOVERIES FROM REDHEADS (*AYTHYA AMERICANA*) BANDED IN NORTHEASTERN CALIFORNIA[1]

WARREN C. RIENECKER
Wildlife Management Branch
California Department of Fish and Game

Population distribution and mortality rates were determined for 6,915 redheads banded in northeastern California from 1948 through 1963. California hunters harvest the majority of the redheads produced in northeastern California. The males range farther than the females and are apt to be found from Mexico to Canada and from coast to coast. The first year mortality rate from all causes for immature redheads was 78.7%. Adults showed an average mortality rate of 41%. Mortality other than hunting losses had a greater effect on the redhead than that recorded for the canvasback (*Aythya valisineria*) by other workers. An average direct band recovery rate of 15.5% was determined for immature redheads during years with an open hunting season on redheads. The data indicated a 4.7% recovery rate during years when the season was closed to redhead hunting. Although the band recovery rate dropped from 15.5% to 4.7% during the closed season, the mortality rate remained high (75.8%). Thus, the season closure had an effect on the band recovery rate but did little toward reducing the mortality on redheads.

INTRODUCTION

This is the second in a series of reports on waterfowl banded in California.

The major objective of these analyses is to determine the population distribution and mortality rates of each species of waterfowl found in California. Without this basic knowledge, a sound management policy can never become a reality. Banding was employed as a means of obtaining this information.

During the period 1948 through 1963, the Pittman-Robertson Waterfowl Research Project W-30-R of the California Department of Fish and Game banded 6,915 redheads in northeastern California. Of these, 6,213 were banded on the Tule Lake and Lower Klamath National Wildlife Refuges in the Klamath Basin near the Oregon border. The remaining 702 redheads were banded on the state-operated Honey Lake Waterfowl Management Area, approximately 150 miles south of the Klamath Basin. The history and description of the two areas have been recorded previously (Naylor, 1953; Rienecker and Anderson, 1960).

The redheads were trapped during August and September in wire traps baited with barley. The majority of the immatures were from 6 to 8 weeks old and had not yet attained their flight feathers.

[1] Submitted for publication June 1967. A contribution of Federal Aid in Wildlife Restoration Project W-30-R, "Waterfowl Studies".

SEX RATIOS

The sex ratio of these local (flightless) redheads was 1.1 males: 1.0 females (52.4% males). This is approximately what Sowls (1955), Lensink (1964), and Bellrose et al. (1961) found in their studies on waterfowl. The slight deviation (2.4%) from a 50:50 ratio is statistically significant, since the sample size is adequate. Fifteen out of 20 samples of redheads banded during the study period contained a slight preponderance of males. For the purposes of this study, it is assumed that this ratio is the same as in untrapped locals and not caused by a bias in the trapping operation.

POPULATION DISTRIBUTION

California hunters harvest the majority of the redheads that are produced in northeastern California (Table 1). Direct recoveries (first fall and winter after banding) indicate that 73.1% of the immature males and 77% of the immature females that are harvested during their first year are taken in California. More than half of these California recoveries are taken within 50 miles of where they were hatched. Other important harvest areas in California are the Sacramento Valley, Imperial Valley, and the San Francisco Bay area.

TABLE 1

Comparison of the Distribution of 1,139 Direct and Indirect Band Recoveries of Redheads Banded as Locals in Northeastern California

Area of recovery	Flyway	Percentage of direct recovery		Percentage of indirect recovery	
		Immature males	Immature females	Adult males	Adult females
Canada		0.4		7.8	0.9
Arizona	Pacific	1.6	1.6	2.9	0.9
California (local)	Pacific	42.6	48.0	17.5	40.2
California (other)	Pacific	30.5	29.0	21.4	21.8
Idaho	Pacific	1.4	1.4	4.9	0.9
Nevada	Pacific	4.6	5.8	1.9	7.7
Oregon	Pacific	3.7	2.8	1.9	4.3
Utah	Pacific	1.0	1.2	6.8	3.3
Washington	Pacific	1.2			
Colorado	Central		0.7		3.3
Kansas	Central			1.9	0.9
Montana	Central		0.2		0.9
Nebraska	Central		0.5	1.0	
New Mexico	Central	0.2	0.5		0.9
North Dakota	Central			3.9	
Oklahoma	Central		0.2	1.9	1.7
South Dakota	Central			1.9	0.9
Texas	Central	5.5	3.5	5.8	4.2
Wyoming	Central	0.4		1.0	
Louisiana	Mississippi	0.2		1.0	
Michigan	Mississippi	0.2		1.0	
Minnesota	Mississippi			2.9	
Wisconsin	Mississippi			1.9	
Florida	Atlantic			1.0	
New York	Atlantic	0.2		1.0	
Virginia	Atlantic		0.2		
Mexico		6.3	4.4	8.7	4.2
Total		100.0	100.0	100.0	100.0

The direct recovery rates show that fewer immature males (42.6%) than females (48.0%) are taken locally (within 50 miles of the banding site). This indicates that the immature males start their migration away from the breeding grounds earlier than the females.

The most obvious difference between the male and female indirect recoveries (second year and over) is in the percentage of recoveries from northeastern California. The data indicate a local recovery rate of 17.5% for the adult males, compared with 40.2% for the adult females. A part of this difference is probably caused by the males molting earlier than the females. Thus, they have the opportunity to move out of the area long before the females and before the beginning of the hunting season. However, the data also imply that the males are wider ranging than the females and are less apt to return to their natal breeding grounds in succeeding years. Normally, when a banded duck is recovered on the northern breeding grounds, it may be concluded that it was also there during the breeding season. This might not be entirely true for the redhead. The fact that some immature redheads are recovered north of their California nesting grounds makes it appear that this northward postbreeding flight could account for some of the adult males recovered in the north. It is possible that some adult males return to northeastern California for the breeding season, then molt on one of the large local lakes such as Upper Klamath Lake or Goose Lake, and later move north before the hunting season opens. It is also a possibility that they move north before molting. The wanderings of the redhead are discussed at length by Weller (1964).

Only 57.3% of the indirect adult males are recovered on the Pacific Flyway, compared with 82.1% of the females. The males are apt to be taken from Canada to Mexico and from coast to coast. However, the west coast of Mexico and the gulf coast of Mexico and Texas are the most important wintering areas outside of California.

RECOVERY RATES

The discrepancy in the yearly percentage of direct band recoveries (Table 2) could be caused by a number of factors. Inadequate sample size for some of the years studied is a possible source of error in the data. Changes in season length and bag limit could have caused variations in the band recovery rates.

Season length in California during the study period varied from 34 to 95 days. Grieb (1964) states that on the Central Flyway changes in length of a short season have a much greater effect on the harvest than similar changes in long seasons. Since approximately 50% of the redhead kill occurs within the first 14 days of the season, it may be assumed that this is true also in California. Early hunting season starting dates find the redheads still concentrated on the breeding grounds such as the Klamath Basin, an area of heavy, concentrated hunting pressure. Late starting dates reduce the local kill by allowing many of the redheads to leave the area before the season starts. The assumption is made that a low local harvest allows a greater percentage of ducks to be harvested elsewhere, but it is also probable that fewer birds would be taken than during a year of a high local harvest.

TABLE 2

A Comparison of the Annual Percentages of Direct Band Recoveries for Redheads Banded as Locals in Northeastern California

	Open hunting season												Closed hunting season				
	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	Total
Number banded	316	117	498	811	239	355	853	185	171	522	800	317	593	206	399	200	6,915
Number recovered	53	19	92	120	30	64	151	32	67	77	94	56	31	10	12	10	921
Percentage recovered	16.8	12.9	18.5	14.7	12.6	18.0	17.7	17.3	14.2	14.8	11.8	17.7	5.7	4.9	3.0	5.0	
Average percentage	**15.5**												**4.7**				

Bag limits varied from zero to six redheads per day. Although the season was closed to redhead hunting from 1960 to 1963, they still received a hunting pressure equal to that of several other species of waterfowl that are hunted legally. A 6% band recovery rate from a 1961 sample of 167 flightless redheads banded in the San Joaquin Valley also verifies this harvest of redheads during the closed season.

Weather conditions can play an important role in the duck harvest and thereby affect the band recovery rate. Early or late storms in northeastern California can have the same effect as early or late starting dates of the hunting season. Years with heavy precipitation on the wintering grounds of California makes some waterfowl habitat inaccessible to hunters, thus reducing the kill and the band recovery rate. Opening day of the hunting season (weekend or weekday) and starting time on opening day (dawn or noon) can contribute to variations in the band recovery rate.

Because of these various factors affecting the recovery rate, data for specific years are of extremely limited reliability. Therefore, only the average direct recovery rates in Table 2 should be considered reliable.

MORTALITY

Since the first year mortality rates for immature male and immature female redheads were nearly the same (78.4 and 78.9%), the data were combined into one life table (Table 3). The life table described by Bellrose and Chase (1950) is used in this paper.

Studies of the canvasback (Geis, 1959), mallard, *Anas p. platyrhynchos* (Bellrose and Chase, 1950), and the lesser snow goose, *Chen hyperborea* (Rienecker, 1965), show the adult female to have a slightly higher mortality rate and a shorter life expectancy than the male. The vulnerability of the female to predation during the nesting and brooding seasons is probably the major cause of this difference. This does not apply to the redheads of northeastern California. The average mortality rate was identical (40%) for males and females two years of age and older. Tule Lake and Lower Klamath National Wildlife Refuges, where the majority of the banding occurred, has an above average redhead nesting success of 88.3% (Rienecker and Anderson, 1960). The redheads' choice of nesting sites in thick cover and over water reduces predation to birds and eggs. This lack of predation upon the female could account for the higher survival of females in northeastern California.

Studies indicate that the immature bird is more vulnerable to hunting pressure than the adult. The immature redhead has an exceptionally high mortality rate of 78.7% during the first year, followed by a mean rate of 41% for subsequent years. Ducks are considered adults after the first year.

The canvasback also has an exceptionally high mortality rate. Geis (1959) reported that the first year mortality rate for immature canvasbacks is 77%, while the rate for adults is between 35 and 50%. He also reported an average band recovery rate of 22% and stated that shooting is responsible for more canvasback deaths than all other factors combined. The percentage of bands recovered from immature redheads is smaller than that from canvasbacks (15.5 to 22%), which indicates that the redheads were exposed to less hunting pressure than the canvas-

TABLE 3

Life Table for Redheads Banded and Recovered During Years with an Open Hunting Season on Redheads

Banding year May 1–April 30	Number banded	Number of bands returned by year of return										
		Direct	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	Total
1948	316	53					1					54
1949	147	19	2	2	1	2	1					27
1950	498	92	13	4	2	1	4	2			1	119
1951	814	120	13	6	5	4	2	2	1			153
1952	239	30	2		5	2	2		1			42
1953	355	64	5	2	1	1						73
1954	853	151	17	8	4	2	1					183
1955	185	32	4	1								37
1956	471	67	9	5								81
1957	522	77	17	3								97
1958	800	94	16									110
1959	317	56										56
Total	5,517	855 of 5,517 banded	98 of 5,200 banded	31 of 4,400 banded	18 of 3,878 banded	12 of 3,407 banded	11 of 3,222 banded	1 of 2,369 banded	2 of 2,014 banded	None of 1,775 banded	1 of 961 banded	1,032
Percentage of bands recovered		15.5	1.9	0.7	0.5	0.4	0.3	0.2	0.1	0.0	0.1	19.7
Mortality series		78.7	9.7	3.6	2.5	2.0	1.5	1.0	0.5		0.5	
Cumulative percentage of bands recovered		78.7	88.4	92.0	94.5	96.5	98.0	99.0	99.5		100.0	
Survival series		21.3	11.6	8.0	5.5	3.5	2.0	1.0	0.5		0.0	
Mortality rate		78.7	45.5	31.0	31.3	36.4	42.9					

backs. However, their mortality rate was greater than that of the canvasbacks, which implies that mortality other than that resulting from hunting has a greater effect on redheads than on canvasbacks.

From 1960 through 1963, the hunting season on redheads was closed. During this period, 1 398 flightless redheads were banded. Although the season was closed, 4.7% of the bands were returned as direct recoveries. When hunting pressure is a main factor in determining the mortality rate of a species, it is assumed that a decline in the band recovery rate would also show a proportionate drop in the mortality rate. The band recovery rate for the redhead dropped two-thirds (15.5 to 4.7%) when the season was closed, yet the mortality rate remained high at 75.8% (Table 4).

One assumption is that natural mortality was replacing hunting mortality during the years closed to redhead hunting. Another and more likely assumption is that hunting mortality was similar during open and closed years, and that therefore the 4.7% recovery rate is a misleading indication of hunting mortality. If the latter assumption is correct, then the true recovery rate is probably close to the 15.5% determined for redheads during the open season. The discrepancy between the two recovery rates may be due to reluctance on the part of the "wiser" hunters to return a band from an illegal species. In any event, the season closure on redheads had an effect on their band recovery rate but did little towards reducing redhead mortality.

DISCUSSION

Most of the redheads shot in California are reared in California and and in the neighboring states within the Pacific Flyway. Lensink (1964) states that only 4% of the redheads banded in Canada exclusive of British Columbia were recovered within the Pacific Flyway. Therefore, the redheads of the Pacific Flyway should be considered virtually a separate population and managed as such. A decrease in the Canadian redhead population, such as the decrease in the past decade, should not have any marked effect on the redhead populations of the Pacific Flyway.

If, in the future, additional data substantiate that Canada and the north-central states furnish few redheads to the Pacific Flyway, the Pacific Flyway hunter should not be penalized for a reduced population of redheads using other flyways.

It is emphasized that first year mortality for immature redheads is 78.7% during years with a hunting season and 75.8% during years without a season—a difference of only 2.9%. Is the redhead population on the Pacific Flyway in such poor condition that we have to close the season just to reduce the mortality rate by 2.9%? It is doubtful.

The major problem in the management of waterfowl by species is the inability of the average hunter to distinguish between the different species of waterfowl. Until this condition improves, regulations such as were set for the redhead (1960–1963) will not have the desired effect on controlling harvest per species. Therefore, in the interim, all other avenues of controlling harvest on a species basis should be thoroughly investigated before adopting a nationwide season closure.

If protective regulations are needed in the flyway for species nesting within the flyway, a delay in opening the season in the nesting areas might be the simplest regulation to gain this end.

TABLE 4

Life Table for Redheads Banded and Recovered During Years without an Open Hunting Season on Redheads

Banding year May 1–April 30	Number banded	Number of bands returned by year of return				Total
		Direct	2nd	3rd	4th	
1960	593	34	5	2	1	12
1961	206	10		1		11
1962	399	12	6			18
1963	200	10				10
Total	1,398	66	11	3	1	81
		of 1,398 banded	of 1,198 banded	of 799 banded	of 593 banded	
Percentage of bands recovered		4.7	0.9	0.4	0.2	6.2
Mortality series		75.8	14.5	6.5	3.2	
Cumulative percentage of bands recovered		75.8	90.3	96.8	100.0	
Survival series		24.2	9.7	3.2		
Mortality rate		75.8	59.9	67.0		

SUMMARY

During the period 1948 through 1963, 6,915 redheads were banded in northeastern California by personnel of Pittman-Robertson Waterfowl Research Project W-30-R of the California Department of Fish and Game.

The majority of the redheads were locals when trapped. The sex ratio of these flightless redheads was 1.1:1.0 (52.4% males).

California hunters harvest the majority of the redheads that are produced in northeastern California. Hunters in northeastern California account for approximately half of the California harvest. Other important harvest areas in California are the Sacramento Valley, Imperial Valley, and the San Francisco Bay area.

The analysis indicates that the adult male compared with the adult female is less likely to return to its natal breeding ground in succeeding years. However, adult males are apt to leave the breeding grounds in northeastern California before the beginning of the hunting season. Consequently, they are harvested elsewhere with no record of having been back to northeastern California. The males can be found from Canada to Mexico and from the Atlantic to the Pacific.

Discrepancies in the yearly percentages of direct band recoveries could be caused by inadequate sample size and by changes in season length, starting date, starting time, bag limit, and weather conditions.

First year mortality rates for immature male and immature female redheads were nearly the same (78.4 and 78.9%). The average mortality rate was identical (41%) for males and females two years of age and older. The fact that the mortality rate of adult females was not greater than that of the males may be the result of less predation upon the females during the nesting season in northeastern California.

The immature redhead has a higher mortality rate and a lower band recovery rate than the canvasback, which implies that mortality other than that resulting from hunting has a greater effect on the redhead than on the canvasback.

The data indicate an average direct band recovery rate of 4.7% for the 4 years (1960–1963) that the hunting season on redheads was closed. Although the band recovery dropped from 15.5 to 4.7% during the closed season, the mortality rate remained high at 75.8%. This reveals that the immature redheads continue to suffer a high mortality regardless of hunting season regulations and that hunting could replace most of the natural mortality.

The redheads of the Pacific Flyway should be considered a separate population and managed as such. Hunters on this flyway should not be penalized for reduced populations using other flyways.

It is doubtful that it is justifiable to close the hunting season on redheads on the Pacific Flyway to reduce the mortality rate by 2.9%. Other means, such as delaying the opening date of the hunting season on the nesting areas, might accomplish this best.

ACKNOWLEDGMENTS

The author wishes to express his appreciation to the personnel of Project W-30-R for assistance in the trapping and banding program and in the tabulation of the data, especially to M. E. Foster and Burton D. Collins, who conducted the banding program at Tule Lake before the author's arrival on the project, to E. G. Hunt and Morris P. Anderson, who banded on the Honey Lake Waterfowl Management Area, and to William Anderson, who banded in the San Joaquin Valley. Thanks are due also to Frank M. Kozlik for guidance in the preparation of this paper and to personnel of the Tule Lake National Wildlife Refuge for cooperating in the program.

REFERENCES

Bellrose, Frank C., and Elizabeth Brown Chase. 1950. Population losses in the mallard, black duck, and blue-winged teal. Ill. Nat. Hist. Surv., Biol. Notes, (22) : 27 p.

Bellrose, Frank C., Thomas G. Scott, Arthur S. Hawkins, and Jessop B. Low. 1961. Sex and age ratios in North American ducks. Ill. Nat. Hist. Surv., Bull., 27 (6) : 391–474.

Geis, A. D. 1959. Annual and shooting mortality estimates for the canvasback. Jour. Wildl. Mangt., 23 (3) : 253–261.

Grieb, Jack R. 1961. Effect of season length and bag size on Central Flyway duck harvest. Proc. 14th Ann. Conf. Western Assoc. State Game and Fish Comm., 197–205, plus 5 figs.

Lensink, Calvin J. 1961. Distribution of recoveries from bandings of ducklings. U.S. Fish and Wildl. Serv., Spec. Sci. Rept.– Wildl. (89) : 146 p.

Naylor, Albert E. 1953. Production of the Canada goose on Honey Lake Refuge, Lassen County, California. Calif. Fish and Game, 39 (1) : 83–94.

Rienecker, W. C. 1965. A summary of band returns from lesser snow geese (*Chen hyperborea*) of the Pacific Flyway. Calif. Fish and Game, 51 (3) : 132–146.

Rienecker, W. C., and William Anderson. 1960. A waterfowl nesting study on Tule Lake and Lower Klamath National Wildlife Refuges, 1957. Calif. Fish and Game, 46 (4) : 481–506.

Sowls, Lyle K. 1955. Prairie ducks; a study of their behavior ecology and management. Stackpole Co., Harrisburg, Pa., and Wildl. Mangt. Inst., Washington, D.C., 193 p.

Weller, Milton W. 1964. Distribution and migration of the redhead. Jour. Wildl. Mangt., 28 (1) : 64–103.

Calif. Fish and Game, 54 (1) : 27–32, 1968.

DETERMINATION OF THE WINTER RANGE OF A BLACK-TAILED DEER HERD IN THE NORTH COAST RANGE OF CALIFORNIA[1]

RICHARD D. BAUER[2]
Mendocino National Forest
Willows, California

JEROME T. LIGHT, JR.
Cleveland National Forest
San Diego, California

WILLIAM R. THORNTON
Wildlife Management Branch
California Department of Fish and Game

The winter ranges for deer *(Odocoileus hemionus columbianus)* summering in the Black Butte-Ford Hill area in the North Coast Range of California were determined by the marking of 47 deer in the summer of 1962. Hardin Hole Ridge and the Euchre Glade area were the principal winter ranges. Migration distances ranged from 4 to 12 air miles. The knowledge obtained from this study is presently being used to manage this deer herd.

INTRODUCTION

To properly manage deer and their habitat, it is essential to know both the winter and summer ranges for each specific herd. With the proper management of a deer herd as the basic objective, 47 deer were trapped and marked in the summer of 1962 by the California Department of Fish and Game and the U.S. Forest Service. The objective was to determine the winter ranges of deer summering in the Ford Hill-Black Butte area of the Mendocino National Forest.

Specifically, the Department of Fish and Game was requested by the Mendocino National Forest to undertake this study. It was hoped that, with both seasonal ranges known, proper management could be prescribed to lessen the depredation on coniferous tree reproduction.

DESCRIPTION OF AREA

Trapping and marking was done on summer range located in Mendocino National Forest, Glenn County, in the North Coast Range of California. This area includes both the headwaters of Black Butte River (tributary to the Middle Fork of the Eel River) and Grindstone Creek (tributary to the Sacramento River). The black-tailed deer (*Odocoileus hemionus columbianus*) population in this area is high. From 1961 to 1965, annual deer use on key areas averaged 148 deer days per acre on summer ranges and 157 on winter ranges. High deer numbers are also evidenced by heavy deer use of browse species.

[1] Submitted for publication March 1967.
[2] Present address: U.S. Bureau of Sport Fisheries and Wildlife, Willows, California.

TABLE 1

Deer Marking Data, Black Butte-Ford Hill Area, 1962

Ear tag number	Area	Date	Sex	Age	Ear		Streamer color	Bell
					L	R		
2401	Black Butte	Aug. 1	F	A	¼ Cut	Tag	White	x
2402	Black Butte	Aug. 9	F	F	¼ Cut	Tag	-	-
2403	Black Butte	Aug. 13	F	A	Tag	¼ Cut	Red	x
2404	Black Butte	Aug. 15	F	F	Tag	¼ Cut	-	-
2405	Black Butte	Aug. 15	F	A	Tag	¼ Cut	Red	x
2406	Black Butte	Aug. 15	F	A	Tag	¼ Cut	Red	x
2407	Black Butte	Aug. 15	F	A	Tag	¼ Cut	Red	x
2408	Black Butte	Aug. 15	F	A	Tag	¼ Cut	Red	x
2409	Black Butte	Aug. 20	M	A	Tag	¼ Cut	Red	x
2410	Black Butte	Aug. 21	F	A	Tag	¼ Cut	Red	x
2411	Black Butte	Aug. 25	F	F	Tag	¼ Cut	-	-
2412	Black Butte	Aug. 26	F	F	Tag	¼ Cut	-	-
2413	Black Butte	Aug. 27	F	F	Tag	¼ Cut	-	-
2414	Black Butte	Aug. 28	F	A	Tag	¼ Cut	Red	x
2415	Black Butte	Aug. 29	F	A	Tag	¼ Cut	Red	x
2416	Black Butte	Aug. 29	F	A	Tag	¼ Cut	Red	x
2417	Black Butte	Aug. 30	F	A	Tag	¼ Cut	Red	x
2418	Black Butte	Aug. 31	F	A	Tag	¼ Cut	Red	x
2419	Black Butte	Sep. 1	M	F	Tag	¼ Cut	-	-
2420	Black Butte	Sep. 2	F	A	Tag	¼ Cut	Red	x
2421	Black Butte	Sep. 5	F	A	Tag	¼ Cut	Red	x
2422	Black Butte	Sep. 5	F	A	Tag	¼ Cut	White	x
2423	Black Butte	Sep. 6	M	F	Tag	¼ Cut	-	-
2424	Black Butte	Sep. 6	F	A	Tag	¼ Cut	White	x
2425	Black Butte	Sep. 6	F	A	Tag	¼ Cut	White	x
*2426	Black Butte	Sep. 7	F	A	Tag	¼ Cut	White	x
2427	Black Butte	Sep. 8	F	A	Tag	¼ Cut	Red	x
2428	Black Butte	Sep. 8	F	A	Tag	¼ Cut	White	x
2429	Black Butte	Sep. 8	M	F	Tag	¼ Cut	-	-
2430	Black Butte	Sep. 9	F	A	Tag	¼ Cut	White	x
2431	Black Butte	Sep. 9	F	A	Tag	¼ Cut	White	x
2432	Black Butte	Sep. 9	F	F	Tag	¼ Cut	-	-

2433	Black Butte	Sep. 9	M	F	Tag	¼ Cut	--	--
*2434	Black Butte	Sep. 10	F	A	Tag	¼ Cut	White	x
2435	Black Butte	Sep. 10	F	A	Tag	¼ Cut	White	x
2436	Black Butte	Sep. 11	F	A	Tag	¼ Cut	White	x
2437	Black Butte	Sep. 11	F	A	Tag	¼ Cut	White	x
2438	Black Butte	Sep. 12	M	F	Tag	¼ Cut	--	--
2439	Black Butte	Sep. 13	F	A	Tag	¼ Cut	White	x
2440	Black Butte	Sep. 13	F	A	Tag	¼ Cut	White	x
2441	Black Butte	Sep. 13	M	F	Tag	¼ Cut	--	--
2442	Ford Hill	Sep. 14	F	A	¼ Cut	Tag	Orange	x
2443	Ford Hill	Sep. 15	F	F	¼ Cut	Tag	--	--
2444	Ford Hill	Sep. 16	F	A	¼ Cut	Tag	Orange	x
2445	Ford Hill	Sep. 17	F	A	¼ Cut	Tag	Orange	x
2446	Ford Hill	Sep. 18	F	F	¼ Cut	Tag	--	--
2447	Ford Hill	Sep. 18	F	F	¼ Cut	Tag	--	--

* Tags removed from deer found dead or injured as retraps. Tags destroyed.

The summer range is from 4,000 to 7,300 feet in elevation. It is primarily a timber zone; the overstory is ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga menziesii*), and white fir (*Abies concolor*); the understory is white thorn (*Ceanothus cordulatus*), bitter cherry (*Prunus emarginata*), and in some areas Brewer oak (*Quercus garryana breweri*). Key areas are comprised mainly of the understory species, with little or no tree overstory.

The winter ranges are from 1,500 to 3,500 feet in elevation on south facing slopes. The principal cover type includes chamise (*Adenostoma fasciculatum*), buck-brush (*Ceanothus cuneatus*), and live oaks (*Quercus dumosa* and *Q. wislizenii*). Annual grass glades comprise important parts of the winter ranges.

The capacity of both the summer and winter ranges recently has been increased by habitat management. The primary enhancement tools have been logging on the summer ranges and brush manipulation (crushing, burning, grass seeding) on the winter ranges.

Migration from the summer range usually occurs during October; the return from the winter range occurs in April and May. The mountain range in the study area is fairly precipitous, resulting in short distances (4–12 air miles) between seasonal deer ranges.

METHODS

Trapping methods included the Clover single gate deer trap (Clover, 1956), the "Improved Deer Snare" (Asheraft and Reese, 1957), and a buried foot snare developed by Lauer A. Foster of the Department of Fish and Game. This latter snare proved to be the most effective.

Deer were marked by ear tagging and cropping, belling, and attachment of colored plastic neck streamers. Techniques of application and descriptions of these markers are discussed by Asheraft (1961).

Watermelon was the most effective bait. Other baits (apples, acorns, alfalfa, potatoes, willow cuttings) were used but with minor success.

Forty-one of the marked deer were trapped in the Black Butte area and six in the Ford Hill area (Table 1). The observations of marked deer were reported mainly by U. S. Forest Service and Department of Fish and Game personnel.

RESULTS AND DISCUSSION

The major wintering area for the marked deer was Hardin Hole Ridge in Grindstone Canyon, locally called Fiddlers Green (Figure 1). The Euchre Glade area is probably a major wintering area for deer summering in the Black Butte area. Only three marked deer were seen here, but this is attributed to the limited number of observer visits to this area. Some deer also winter in the lower elevations to the east and south of Alder Springs.

Thirty-five observations of marked deer were made from 1962 to 1966; of these, 26 occurred on wintering grounds. A major portion of the winter observations (16), occurred on Hardin Hole Ridge.

The migration distance from the Black Butte-Ford Hill area to the Hardin Hole Ridge winter range is from 6 to 8 air miles. It is only 4 to 5 miles from Black Butte to the Euchre Glade winter range. The longest migration evident from this study is 12 miles.

The return of deer to the same summer range is apparent from the three observations made at Snow Basin in the Black Butte area (one each in 1964, 1965, 1966). The return to the same winter range was demonstrated by two observations of marked deer on Hardin Hole Ridge during the second year after trapping. Gruell (1958), Leopold et al. (1951), and Zalunardo (1965) record the tendency of mule deer to return to the same wintering ground for at least 2 successive years. This tendency of deer to live in the same immediate summering and wintering areas each year is probably more common than is generally realized.

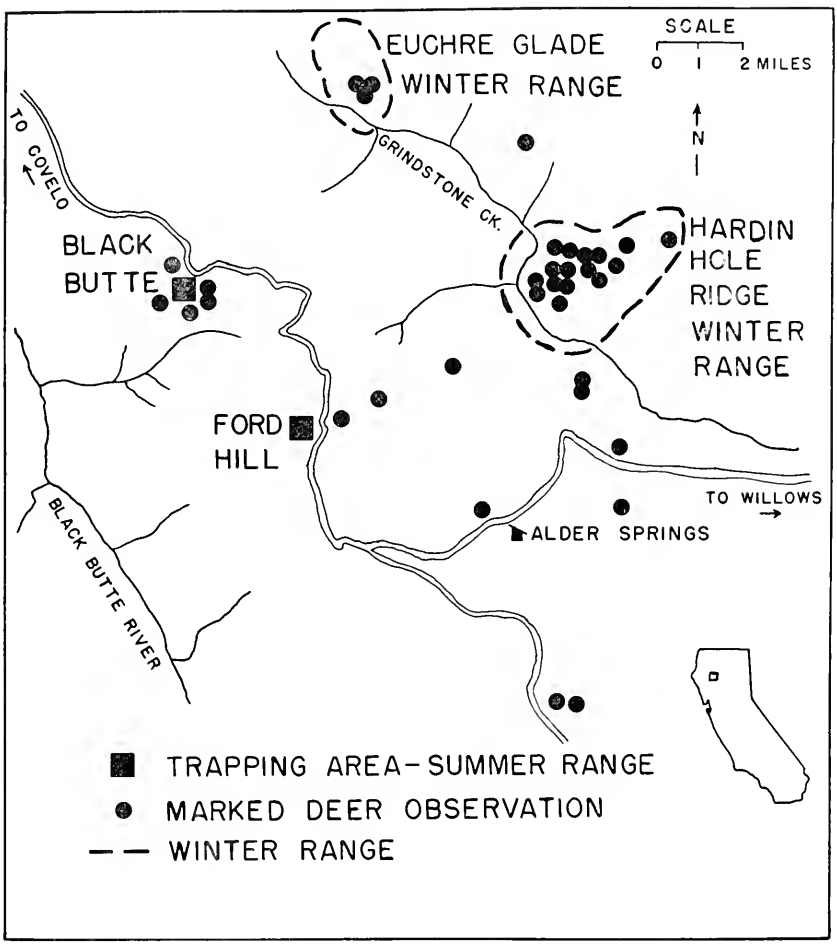

FIGURE 1—Location of trapping areas, marked deer observations, and winter ranges of marked deer.

No marked deer were seen on the wintering area in the Black Butte River drainage, even though it is only 4 miles distant from the Black Butte summer range. However, a limited number of deer may have migrated there without being observed.

The retention of markers (neck streamers, bells, ear tags) was good. Ear tags were retained best. Except for one bell, these were the only type observed in the last 2 years (1965 and 1966). Belling of deer was rewarding because of the difficulty of observation in brushy areas. Eleven deer were identified by bell sounds. The last identification of a belled deer was in December of 1964, the third winter after marking.

The knowledge obtained from the study is presently being used in managing this deer herd. As vegetation on both summer and winter ranges is heavily utilized by deer and the areas are also within close proximity of each other, special antlerless deer harvests will be proposed, with both areas included within the hunt boundary. This will facilitate an adequate harvest if the hunt is approved, since the deer herd will be available throughout the season.

It was realized that considerable habitat improvements on only one of the seasonal ranges could have detrimental effects upon the unimproved range. Brush manipulation on approximately 930 acres on Hardin Hole Ridge has been carried out in the last 6 years. This undoubtedly has increased the carrying capacity for this area and has probably increased winter survival. This would result in a larger number of deer returning to the already overused summer range. To what degree this has increased use on the summer range is not known, but it could have been considerable if it were not for the logging of virgin timber areas, which has created new habitat. The land manager must take such situations into account when planning habitat management on seasonal deer ranges.

REFERENCES

Asheraft, G. C. 1961. Deer movements of the McCloud Flats herds. Calif. Fish and Game 47 (2) : 145–152.

Asheraft, G. C., and D. Reese. 1957. An improved device for capturing deer. Calif. Fish and Game 43 (3) : 193–199.

Clover, M. R. 1956. Single-gate deer trap. Calif. Fish and Game 42 (3) : 199–201.

Gruell, G. 1958. Results from four years of trapping and tagging deer in northeastern Nevada. Proc. 38th Ann. Conf. Western Assoc. State Game and Fish Commis., 179–183.

Leopold, A. S., T. Riney, R. McCain, and L. Tevis, Jr. 1951. The Jawbone deer herd. Calif. Dept. Fish and Game, Game Bull., (4) : 139.

Zalunardo, R. A. 1965. Movements of a mule deer herd. Jour. Wildl. Mangt. 29 (2) : 345–351.

Calif. Fish and Game, 54 (1) : 33–42. 1968.

A FOOD HABITS STUDY OF THE SOUTHERN SEA OTTER, *ENHYDRA LUTRIS NEREIS*[1]

EARL E. EBERT
Marine Resources Operations
California Department of Fish and Game

Feeding behavior of sea otters was studied during the spring and summer of 1966. Shoreside observations and SCUBA diving were employed to note foraging habits relative to food availability. Results of prior sea otter food habits studies are compared with this study. A general agreement of food types between this study and prior studies was found, but a wide variance was apparent when percentage values of foods ingested by otters were compared. Availability appears to be the key factor in sea otter feeding habits. Preferred foods are sea urchins, abalones, and crabs.

A study to interpret the geographic expansion of sea otters and determine their range carrying capacity is recommended.

Feeding behavior of the southern sea otter, *Enhydra lutris nereis* (Merriam), has been reported by Fisher (1939), Limbaugh (1961), Hall and Schaller (1964), and Richard A. Boolootian (Senate Permanent Factfinding Committee on Natural Resources, 1965). These studies, conducted in the general vicinity of Monterey, California, indicated that specific food items were dominant in the sea otter's diet, but there was some disagreement among investigators as to which items predominated.

Fisher's study reported the red abalone, *Haliotis rufescens,* to be dominant. Additional food items included sea urchins, crabs, and seaweed. Unfortunately, Fisher did not report percentages of various food items ingested, and she did not identify the species of crabs and sea urchins involved.

Limbaugh, while filming the activities of sea otters near Monterey, reported that red abalones, red sea urchins, *Strongylocentrotus franciscanus,* rock scallops, *Hinnites multirugosus,* California sea mussels, *Mytilus californianus,* and "various species of snails" were inclusive in the otter's diet. Limbaugh also mentioned that it was possible that otters fed upon the gum boot chiton, *Cryptochiton stelleri.* Limbaugh, like Fisher, did not indicate percentages of various food items ingested, precluding a determination of dominant food items.

Hall and Schaller carefully recorded the tool-using behavior of sea otters and noted their food habits. They found that sea mussels constituted 40% of the items eaten, followed by sea urchins (32.8%), crabs (14.5%), and abalones (9.9%).

Boolootian made comprehensive observations on sea otter feeding habits during a 6-year period. He reported that sea urchins predominate in the otter's diet (56.4%), followed by the California sea mussel (33.8%), and abalones (8.2%).

[1] Submitted for publication July 1967. Prepublished as MRO Reference No. 67-18, "Food habits of the southern sea otter, *Enhydra lutris nereis,* and ecological aspects of the population and distributional expansion."

In 1966, I observed a herd of 34 to 38 sea otters in the vicinity of Pico Creek (lat. 35° 37′ 10″ N., long. 121° 08′ 14″ W.), approximately 100 miles south of Monterey. At the time, this herd was near the southernmost limits reported in recent years for sea otter concentrations; however, in 1967 a herd of 25 to 30 sea otters moved farther south into the Cambria region (Figure 1).

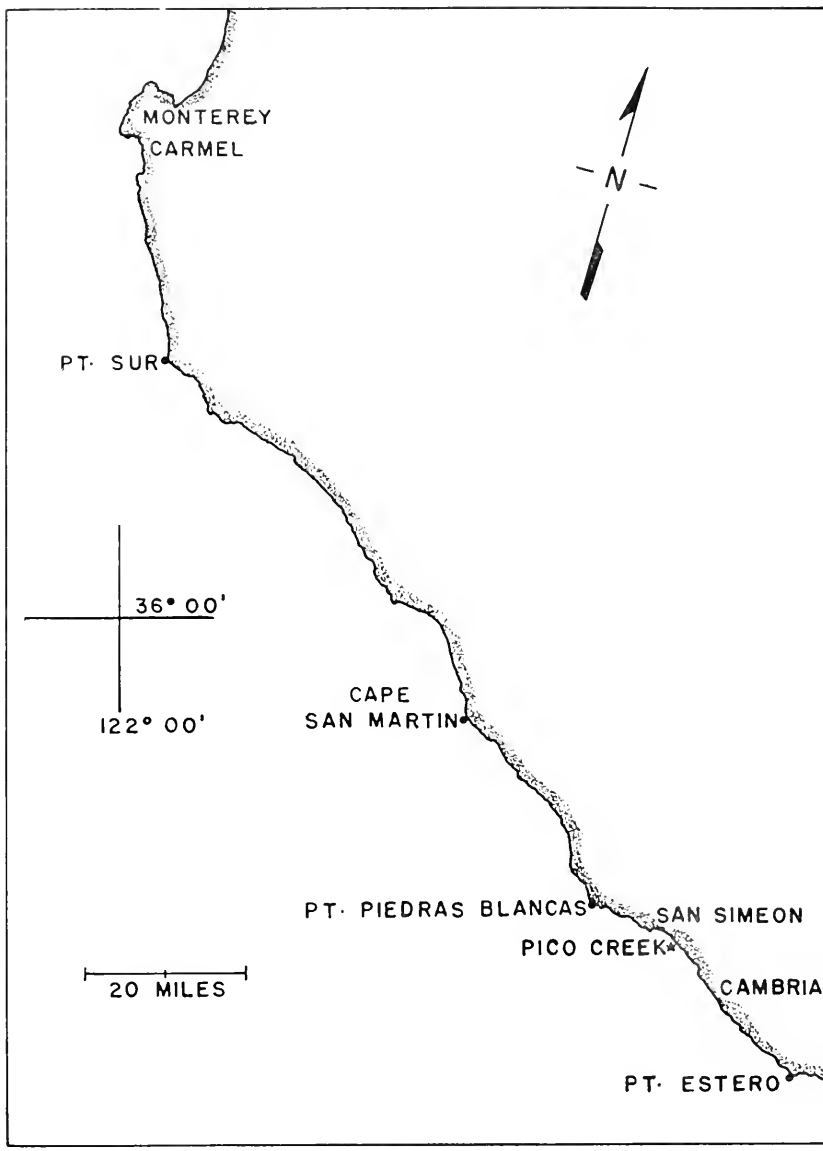

FIGURE 1—Central California coast. The sea otter herd investigated in this study was located at Pico Creek.

I studied the Pico Creek herd's feeding habits at different times between March and October. I made shore observations with a 30X spotting scope and used SCUBA gear to make observations of the benthos. The biomass of food organisms was measured to determine the potential yield an otter might obtain from a particular food item. For the purposes of this study, biomass is considered the difference between total wet weight and inedible hard body parts.

Presumably the yield that an otter can obtain from a particular food type influences preference values. In prior studies of southern sea otter feeding habits, scant attention was directed toward determining relative yields of various food items ingested by otters. Only percentages of food types were reported, and this can be misleading because only quantitative values are represented. Samples of sea otter food items collected in the central California region indicate that otters obtain maximal biomass yields, averaging 695 g, from red abalones. An average sea mussel near Pico Creek yields only 11 g, a red sea urchin 232 g, and a purple sea urchin 22 g (Table 1). By quantitatively equating various organisms in terms of biomass, one red abalone equals:

63.0 sea mussels
10.7 rock scallops
3.0 red sea urchins
31.6 purple sea urchins
2.2 gaper clams

These data show that those food types yielding greater biomass are also prefered food types. Data were not obtained for rock crabs, starfish, or the gum boot chiton.

TABLE 1

Total Weight and Biomass Values for Organisms Fed Upon by Sea Otters

Organism	Total wt.(g)*	Biomass(g)*
California sea mussel	21	11
Rock scallop	260	65
Gaper clam	445	314
Red abalone	990	695
Red sea urchin	737	232
Purple sea urchin	43	22

*Mean values weighed to nearest gram. Minimum of 10 specimens each.

Sea otters have been noted to roll over constantly on the surface while feeding on larger food items, such as crabs and abalones. This has been interpreted by many investigators to be food-washing behavior; nevertheless, my observations lead me to concur with Barabash-Nikiforov, Reshetkin, and Shidlovskaya (1947), who recognized this behavior to be a mechanism for preventing food remnants from entering the otter's delicate pelage. This became evident while viewing otters feeding upon eviscerated abalones extracted from the shell. Only the large muscular foot remained and this required no cleaning, yet the otters continued to exhibit the rolling behavior.

At Pico Creek, the otter herd rafted on the outer edge of a bed of giant kelp, *Macrocystis angustifolia*. This bed was located in water 50 to 60 feet deep. The herd's location did not change perceptibly from March through July. The otters foraged within the giant kelp bed and shoreward to the intertidal zone. The red abalone was noted to be the principal food item, followed by rock crabs and gaper clams (Table 2).

TABLE 2

Food Items of Sea Otters at Pico Creek
April 21 to June 2, 1966 *

Food item	Number of observations	Percentage of total
Red abalone, *Haliotis rufescens*	154	63.4
Rock crab, *Cancer antennarius*	63	25.9
Gaper clam, *Tresus nuttalli*	6	2.5
Rock scallop, *Hinnites multirugosus*	5	2.1
Giant kelp, *Macrocystis angustifolia*	3	1.2
California sea mussel, *Mytilus californianus*	2	0.8
Sea cradle, *Cryptochiton stelleri*	1	0.4
Unidentified	9	3.7
Totals	243	100.0

* Seven dates totaling 35 hours of observations involved during this period.

How otters remove abalones from the substrate has been a controversial subject. Kenyon (1959) shed some light on this issue when he reported that captive otters dislodged the metal fixture of a pool drain by pounding it with a stone. All stones in the pool eventually had to be removed because the otters were inflicting considerable damage to the pool's cement edges.

Before recovering abalones, otters are frequently seen at the surface with softball-sized rocks. Diving, they carry a rock between their forepaws, locate an abalone and, with very short but powerful arm movements from the chest region, pound it until the shell fractures (Ernie Porter, a professional diver, pers. comm.). The exterior surfaces of many empty abalone shells at Pico Creek have shiny indentations that appear to be the result of a series of sharp blows with a blunt instrument (partially corroborating the above communication).

About 80% of the abalones brought to the surface by otters at Pico Creek had shells exhibiting a variety of breakage planes. Shell fractures characteristically occurred near the nuclear whorls and along the respiratory pore line near the shell's periphery. Approximately 15% of the abalones had their shells intact, while the remaining 5% were brought to the surface shell-less. I examined several hundred broken abalone shells, and generally those that were older, well bored, and weakened exhibited breaks adjacent to the nuclear whorls, while sturdier shells displayed breaks along the anterior-most respiratory pores.

When seeking food, an abalone quite often assumes a position with its shell raised several inches above the substrate and only the posterior third of the foot attached. This affords a better opportunity for entrapping drifting algae. Abalones caught in this position are easily dislodged from the substrate, and this can account for abalones intact in shells being brought to the surface by sea otters.

In April 1966, otters were observed to surface with one abalone per two dives; by June, otters were diving 9 to 10 times before surfacing with an abalone invariably exhibiting the effects of severe pounding.

Sea otters at Pico Creek ate from two to four abalones per feeding. Typically, three were consumed, plus a crab or other food item. Otters reportedly feed once daily (Fisher, 1939). My observations neither confirmed nor refuted this because no more than a third of the herd fed at one time, and I could not distinguish whether animals that fed earlier on a specific day were present when the second general feeding period was initiated. Boolootian (Senate Permanent Factfinding Committee on Natural Resources, 1965) reports that an average sea otter weighing 22.7 kilograms consumes no more than 5.4 kilograms of food daily. Kenyon (1959) noted that captive subadult and adult otters required at least 2.7 kilograms of fish daily, but 3.6 kilograms were preferable. An average red abalone at Pico Creek (approximately 18 cm long) yields about 700 g of biomass, suggesting that one daily meal at Pico Creek is sufficient to meet an otter's minimum daily requirement.

Confirmation of gaper clams in the otter's diet was initially made by diving and collecting empty broken valves after an otter had been noted feeding on what appeared to be a gaper at the surface. Subsequently, many broken gaper clam valves have been observed on the bottom where otters have been actively foraging. Typical gaper clam habitat is from 1 to 3 feet beneath sandy substrate and in more protected situations. At Pico Creek, gapers occur in the sandy expanses between rocky reefs and apparently are exposed during strong surge conditions and attendant heavy sediment transport.

Significantly, I did not see the otters eat any sea urchins. This was not unexpected because no live red sea urchins were seen while diving, although their spines and test fragments profusely littered the seafloor, attesting to their former presence. Small concentrations of purple sea urchins, *Strongylocentrotus purpuratus*, that typically occur intertidally were present in the low-tidal region but they were relatively inaccessible.

Kelp crabs, *Pugettia producta*, abalone jingles, *Pododesmus cepio*, and keyhole limpets, *Megathura crenulata*, were notably depleted at Pico Creek. Although not documented as otter food during this study, they apparently were foraged upon and quite likely were recorded as unidentified food items (Table 2).

DISCUSSION

According to Barabash-Nikiforov et al. (1947), captive otters feed without displaying any food preferences. However, Vania (1967) noted that captive sea otters were very reluctant to accept chum salmon, *Oncorhynchus keta*, and pink salmon, *O. gorbuscha*, after their normal food supply of Dungeness crab became depleted. The otters would not eat the fish for a period of 24 hours, and during this time they were considerably more nervous and exhibited increased hostility towards one another.

Comparison of the data from various food studies of the southern sea otter reveals that a fair correlation exists between food types, but dis-

TABLE 3

Comparison of Food Habits of the Sea Otter Recorded for the Monterey Area and Pico Creek, California [1]

Food item	Monterey (Fisher, 1939)	Monterey (Hall and Schaller, 1964)	Monterey (Boolootian)[2]	Pico Creek (this study)
Seaweed	tr.	0.2	--	1.2
Spiny lobster	--	0.6	0.1	--
Crab	"Common"	11.5	0.8	25.9
Gaper clam	--	--	--	2.5
Sea mussel	--	40.0	33.8	0.8
Rock scallop	--	--	--	2.1
Chiton	--	0.8	0.2	0.4
Abalone	"Dominant"	9.9	8.2	63.4
Octopus	--	0.4	0.1	--
Purple sea urchin	--	32.4	13.0	--
Red sea urchin	"Common"	0.4	43.4	--
Starfish	--	0.6	0.2	--
Fish	--	0.2	0.1	--
Unidentified	--	--	--	3.7
Totals	--	100.0	99.9	100.0

[1] Values, where available, are listed as percentages of the total.
[2] Senate Permanent Factfinding Committee on Natural Resources (1965).

parities become evident when percentages of food types ingested are examined (Table 3). Unfortunately, prior investigators did not incorporate diving with shoreside observations to note availability and relative abundance of food items. Fisher (1939) did relate that otters moved from a specific area when the food supply was depleted, and quite significantly she reported that otters did not forage on sea mussels, although they abounded on the nearshore rocks. Twenty-five years later, Hall and Schaller (1964) reported that mussels, numerically, comprised 40% of the otter's diet. Both studies were conducted in the general vicinity of Monterey. This suggests that at the time of Fisher's study other food items such as sea urchins, abalones, and crabs were more abundant and were preferred to sea mussels. At Pico Creek, sea mussels were abundant on the intertidal rocks but the otters rarely utilized them (Table 2). Similarly, gum boot chitons and sea stars (*Pisaster ochraceus*, *P. giganteus*, and others) occurred on exposed rocky surfaces, but only once were any of these sought.

Diving observations indicated that abalones, crabs, rock scallops, and gaper clams were utilized relative to their availability and these items, therefore, were preferred over mussels, sea stars, and chitons.

Sea otters migrated into the Pico Creek region in December 1965 (Russell Goodrich and Howard Martin, Department game wardens, pers. comm.). Sea urchins undoubtedly were present in the otter's diet then, but only test fragments and spines were evident by March 1966. Sea urchins are often the most dominant benthic organism along the California coastline. Aside from the sea otter, the chief predator of adult red sea urchins in central California is the sun star, *Pycnopodia helianthoides*. The subtidal depletion of sea urchins at Pico Creek and results of prior studies indicate that sea urchins are not only preferred food but are generally accessible to foraging otters.

Because red sea urchins predominately occur subtidally in exposed situations, they are more readily obtained by foraging otters. Purple sea urchins occurring near the lower tidal region and often in crevices or burrows of their own making are less accessible to the otters. In addition, purple sea urchins are substantially smaller than red sea urchins and offer considerably less biomass (Table 1).

Boolootian (Senate Permanent Factfinding Committee on Natural Resources, 1965) reported that the otter's diet consisted of 43.4% red sea urchins and 13.0% purple sea urchins (Table 3). Conversely, Hall and Schaller (1964) noted 0.4% red sea urchins and 32.4% purple sea urchins in the otter's diet. Based on knowledge derived at Pico Creek, these data suggest that Boolootian's investigations were conducted in locations where sea otters had only recently foraged, whereas Hall and Schaller studied in an area where considerable depletion of accessible and more preferred food types had occurred.

McLean (1962), conducting an ecological study using SCUBA in the kelp beds near Carmel on the Monterey Peninsula, noted the absence of sea urchins, although spines and test fragments were present. He concluded that this was the result of sea otter predation. McLean reported a few red abalones were in crevices and flat abalones, *H. walallensis*, were present beneath rocks.

How rapidly sea urchins may repopulate a specific area is not known. However, under laboratory conditions, both red and purple sea urchins grow approximately 2.5 cm diameter annually (David Leighton, Scripps Institution of Oceanography, pers. comm.). Size composition of red sea urchins south of Pico Creek suggests that the observed laboratory growth rate may be a conservative figure. Nevertheless, observed laboratory growth rates indicate that red sea urchins attain adulthood in 3 to 4 years, while purple sea urchins may mature in 2 years.

Having optimal conditions, red abalones will attain 18-cm shell lengths in 4 to 5 years. At shell lengths less than 12 cm, they are highly negatively phototactic, stay deep in crevices or beneath rocks, and are generally inaccessible to foraging otters.

In October 1966, a series of reconnaissance dives was made commencing about 5 miles north of Pico Creek and proceeding southward in 15- through 50-foot depths to 3 miles south of the creek. Red sea urchins were first encountered about 1 mile south of Pico Creek; normal red sea urchin densities for this area (about 0.9 per M^2) occurred about a mile farther south and apparently marked the southern limits of herd-sized otter movements.

Terminal dives at Pico Creek in October revealed numerous abalone shells and occasional rock scallop and gaper clam valves littering the substrate. A few live red abalones were present, but inaccessible, in deep crevices, while flat and pinto, *H. kamtschatkana*, abalones were common under rocks.

Adult red sea urchins are intensive vegetative grazers, considerably more effective than adult abalones, chiefly because of their habitat, mobility, and numerous spines that effectively entrap drifting seaweeds.

Although adult abalones and sea urchins are food competitors, juvenile abalones, particularly the flat abalone and to a lesser extent the pinto and red abalones, paradoxically are often commensal with red sea urchins in the bull kelp, *Nereocystis luetkeana*, communities of cen-

tral California. When commensal, these juvenile abalones (up to 6.3 cm long) occur beneath the sea urchin, presumably moving with the sea urchin and feeding on seaweed fragments obtained by the sea urchin.

A recent population census of southern sea otters (Carlisle, 1966) revealed 591 individuals inhabiting the central California coast from Monterey south to near Cayucos. Severe overexploitation by fur hunters in the 1700's and 1800's and the otters' subsequent recovery from near extinction in the early 1900's have been thoroughly documented.

The fact that sea otters were once plentiful suggests that in the past abalones, sea urchins, and other organisms fed upon by otters were relatively minor faunal constituents. It may be that many of these species sought by sea otters for food were largely confined to inaccessible crevices or to intertidal situations where they would be less vulnerable to sea otter predation because of physical limitations of the otter and the otters themselves would be vulnerable to coastal Indians.

This view is favored because enormous quantities of abalone shells are present in Indian middens and shell mounds found along the central California coastline and among the Channel Islands. I confirmed many red abalone and black abalone, *H. cracherodii*, shells from Indian middens at a site adjacent to Pico Creek. This site was being uncovered by archaeologists from the University of California at Los Angeles during the summer of 1966. Correspondingly, skeletal remains of sea otters are not uncommon in Indian middens along the central California coastline.

Undoubtedly the Indians had to obtain their abalones from very shallow water, since their diving prowess would be considerably impaired without a faceplate. In addition, my diving observations indicate that abalone populations cannot flourish sublittorally in the presence of sea otters.

A controversy concerning the extent to which sea otters affect the abalone resource has raged for more than a decade. Abalone fishermen report severe depletion of beds, while other groups are divided. Some conclude that damage to the resource is negligible; still others recognize that very keen competition exists between the sea otter and commercial abalone fishermen. This division accrues mainly from evidence reported in prior investigations. However, without prior knowledge concerning relative availability and utilization of food organisms, the results of these investigations become negated for purposes of ascertaining to what extent sea otters affect the abalone resource.

Department biologists tagged more than 400 red abalones at Stillwater Cove, near Monterey, in July 1956. The following June they returned to the same area but could not locate tagged abalones. Divers traversed more than $\frac{1}{2}$ mile of bottom but found only one red abalone about 6 inches long deep in a crevice. Empty abalone shells and sea urchin fragments littered the substratum. In this same area, Department biologists recovered, tagged, and replaced more than 100 abalones per day during a 4-day period the preceding year. Department records indicate that the depletion of abalones at Stillwater Cove correlates with the arrival of sea otters in late 1956.

I made an examination of the benthos at Stillwater Cove in October 1965 and did not find abalones, although habitat and available food appeared excellent.

In the food studies by Boolootian and Hall and Schaller (Table 3), abalones quite probably comprised less than 10% of sea otter food because of their limited numbers in the areas investigated. Only through diving surveys coupled with shoreside observations could this have been verified.

In 1939, Fisher recognized that keen competition would exist in the future between abalone fishermen and sea otters. Cox (1962) reported that further expansion by the sea otter population to the south "could conceivably place sea otters in an area where they would be competing with commercial abalone fishermen". Evidence at Pico Creek and along the Monterey Peninsula indicates that as the sea otters move onto the commercially valuable abalone beds south of Pico Creek, they will deplete these beds to such an extent that they will no longer support a commercial fishery.

How extensively sea otters may deplete an abalone bed is dependent upon its substrate characteristics. At Pico Creek, all abalones except those beneath rocks or in crevices and therefore inaccessible to the sea otters were removed.

The carrying capacity of the sea otter's present range is not known. Fisher (1939) noted that otters move from a particular cove or kelp bed region after depleting available food. Carlisle (1966) found that sea otters disperse into small herds during winter months, and regroup into larger herds during summer months. Food requirements, environmental conditions, or inherent biological factors may be involved in this behavioral pattern. In recent years, the range of the sea otter has slowly expanded both north and south. A study is needed to interpret this geographic expansion and determine how many otters a given range can support. Obviously, former population levels cannot be supported because man, through urbanization, pollution, and fishing, has reduced the available sea otter habitat and affected its carrying capacity.

Sea otters exert a profound influence upon benthic communities. Their foraging activities on the herbivores, sea urchins and abalones, result in marked vegetative restoration. This is evident throughout most of the otters' range of distribution, and especially so in the Monterey region, where otters have foraged for several years. This vegetative restoration permits optimal feeding conditions and growth for surviving sea urchins and abalones.

Evidence indicates that sea otters are very important members of the climax community that exists along our coastline. They effectively limit sea urchin populations which, because of great numbers, can become a serious problem in restricting algal growth. Sea urchins have little economic importance when compared with abalones, which support a valuable fishery. The competition of otters and commercial divers for red abalones has resulted in requests for a management program that will retain both the esthetically valuable sea otters and the economic return from abalone beds.

ACKNOWLEDGMENTS

I am indebted to Russell Goodrich and Howard Martin, who brought to my attention the sea otter herd at Pico Creek and provided diving assistance. Glen Bickford contributed substantially through his intimate

knowledge of abalone populations and sea otter behavior. Harold Orcutt and Herbert Frey assisted materially by editing the manuscript.

REFERENCES

Barabash-Nikiforov, I. I., V. V. Reshetkin, and N. K. Shidlovskaya. 1947. The sea otter. Translated from the Russian by A. Birron and Z. S. Cole, 1962. Washington, D.C., Natl. Sci. Found., 227 p. (Israel Program for Scientific Translations, Jerusalem.)

Carlisle, John G. 1966. Aerial censuses of California sea otters in 1964 and 1965. Calif. Fish and Game, 52 (4) : 300-302.

Cox, Keith W. 1962. California abalones, family Haliotidae. Calif. Dept. Fish and Game, Fish Bull., (118) : 1-133.

Fisher, Edna M. 1939. Habits of the southern sea otter. Jour. Mammal., 20 : 21–36.

Hall, K. R. L., and George B. Schaller. 1964. Tool-using behavior of the California sea otter. Jour. Mammal., 45 (2) : 287–298.

Kenyon, Karl W. 1959. The sea otter. Smith. Inst. Wash. Rept., 1958 : 399–407.

Limbaugh, Conrad. 1961. Observations on the California sea otter. Jour. Mammal., 42 (2) : 271–273.

McLean, James H. 1962. Sublittoral ecology of kelp beds of the open coast area near Carmel, California. Biol. Bull. 122 (1) : 95–114.

Senate Permanent Factfinding Committee on Natural Resources. 1965. The sea otter and its effect upon the abalone resource, p. 129-141. *In* Third Prog. Rept. to the Legislature, 1965 Reg. Session, Sec. 1, Senate, State of California, Sacramento.

Vania, John. 1967. Sea otter, p. 6-13. *In* Marine mammal investigations, Alaska Dept. Fish and Game, Vol. 8, Annual Project Segment Rept., Fed. Aid in Wildl. Restoration, Project W-14-R-1 and 2, Work Plan G.

Calif. Fish and Game, 54 (1) : 43–48. 1968.

THE ABILITY OF WASHINGTON ANGLERS TO IDENTIFY SOME COMMON MARINE FISHES[1]

FRANK HAW and RAYMOND M. BUCKLEY
Research Division
Washington Department of Fisheries

The practicability of management schemes and accuracy of voluntarily submitted catch data may depend on identification of fishes by anglers. A survey using fresh specimens of common marine fishes, involving 909 Washington salmon anglers, was conducted and responses tabulated. Small (16 cm–52 cm FL) chinook (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) comprised 75% of the test specimens. The other fishes used were copper rockfish (*Sebastodes caurinus*), lingcod (*Ophiodon elongatus*), rock sole (*Lepidopsetta bilineata*), Pacific sanddab (*Citharichthys sordidus*), Pacific cod (*Gadus macrocephalus*), Pacific staghorn sculpin (*Leptocottus armatus*), shiner perch (*Cymatogaster aggregata*), and sablefish (*Anoplopoma fimbria*). Results of the survey demonstrated: prevalent inability of anglers to identify the fishes listed above; improved recognition of chinook salmon after receiving a simple clue; more difficulty in recognition of smaller coho salmon than larger ones; infrequent use of recommended common names.

INTRODUCTION

To comply with angling laws adopted by management agencies, most anglers have been obligated to identify species or taxonomic groups of fishes. The required identifications range from simple to extremely difficult. Few northwest anglers have difficulty separating Pacific salmon (*Oncorhynchus*) from spiny dogfish (*Squalus acanthias*), but it is more difficult to distinguish steelhead trout (*Salmo gairdneri*) from coho salmon. An extreme test of taxonomic prowess occurs in Washington, where regulations require differentiation between anadromous sockeye salmon smolt (*O. nerka*) and kokanee salmon—the smaller lacustrine form of the species.

Anglers have provided catch-composition information by postal card (Ryan, 1959; Seeley, Tharratt, and Johnson, 1963) and by personal contacts in their homes, as in a 1960 national saltwater survey described by Clark (1962). The accuracy of surveys and feasibility of management practices may depend on the anglers' ability in fish identification. To test this ability, a survey using fresh specimens and emphasizing small chinook and coho salmon was undertaken.

METHODS AND MATERIALS

Participants

Anglers, usually embarking on or returning from fishing excursions, were contacted at boat ramps, boathouses, and moorage facilities in popular Washington marine fishing areas. The possession of a Washington salmon catch record (punch card), required for salmon angling, and an age of 16 years or more were qualifying criteria for participation.

[1] Submitted for publication May 1967.

Participants contacted by area, on 19 calendar days from May 22 through September 10, 1966, numbered as follows: Puget Sound—469, Juan de Fuca Strait—239, and the southwest Washington coast—201. Puget Sound anglers participated at Olympia, Tacoma, Seattle, Ed-

TABLE 1

Frequencies That Various Names Were Used for Identification of Species in the Survey

Species[1]	Name and frequency used[2]
Coho salmon[3] *Oncorhynchus kisutch* Fork length: Range 18–52 cm Average 38.5 cm	**Silver—767,** king—98, blackmouth—80, salmon—64, humpy—59, chinook—26, trout—19, steelhead—14, herring—11, sockeye—9, cutthroat—8, seatrout—8, **coho—7,** jack salmon—7, **hooknose—7,** rainbow—6, silver trout—3, dog salmon—3; pink salmon, humpback, bass, mackerel, blueback, smelt, chum, cod—2 each, **silver jack—1;** other names used only once—17, no response—183, (total—1413).
Chinook salmon[4] *Oncorhynchus tshawytscha* Fork length: Range 33–47 cm Average 37.9 cm	**Blackmouth—388, king—294,** silver—236, **chinook—76,** salmon—60, humpy—41, jack salmon—16, steelhead—12, trout—10, pink—8, sockeye—8, cutthroat—6; seatrout, tom cod, cod, herring, blueback, chum and dog salmon—2 each, **tyee—1;** other names used only once—9, no response—135, (total—1314).
Copper rockfish *Sebastodes caurinus* Fork length: 31 cm	**Rockcod—46,** cod—45, bass—38, seabass—36, perch—6, rockfish—6, rockbass—5, black bass—4, lingcod—3, red snapper—3, rock—3, kelpcod—2, grouper—2, snapper—2; other names used only once—8, no response—40, (total—219).
Lingcod *Ophiodon elongatus* Fork length: 75 cm	**Lingcod—68,** cod—40, mackerel—11, seabass—9, hake—9, rockcod—5, **ling—5,** seatrout—2, chinook—2; other names used only once—14, no response—35, (total—200).
Pacific sanddab *Citharichthys sordidus* Fork length: 22 cm	Sole—108, flounder—33, **sanddab—8,** halibut—6, perch—3, seabass—2; other names used only once—10, no response—18, (total—188).
Rock sole *Lepidopsetta bilineata* Fork length: 28 cm	Sole—60, flounder—26, flatfish—2, sanddab—2; other names used only once—6, no response—3, (total—99).
Pacific staghorn sculpin *Leptocottus armatus* Fork length: Range 18–30 cm Average 27.7 cm	**Bullhead—39,** cod—7, sculpin—2; other names used only once—12, no response—8, (total—68).
Shiner perch *Cymatogaster aggregata* Fork length: 13 cm	Perch—17, **pogie—9, shiner—9,** sunfish—2, silver—2; other names used only once—3, no response—9, (total—51).
Sablefish *Anoplopoma fimbria* Fork length: 34 cm	Hake—5, cod—2, **sablefish—2,** lingcod—2, tomcod—2; other names used only once—9, no response—13, (total—35).
Pacific cod *Gadus macrocephalus* Fork length: 28 cm	**Cod—7,** rockcod—2, **true cod—2,** ratfish—2, lingcod—2; other names used only once—2, no response—2, (total—19).

[1] Common and scientific names recommended by the American Fisheries Society (1960).
[2] Names regarded as indicating recognition of the species are printed in boldface.
[3] Silver salmon is the official common name of this species in California.
[4] King salmon is the official common name of this species in California.

monds, Mukilteo, and Seabeck on Hood Canal. Juan de Fuca Strait anglers were contacted at Freshwater Bay, Crescent Bay, Sekiu, and Neah Bay. The coastal sites were Ilwaco and Westport. There was no indication that an individual participated in the survey more than once.

Specimens

All of the fishes used were included specifically or categorically in Clark's (1962) survey. Half of the salmon and all of the other specimens were collected by angling in Puget Sound. The other salmon were obtained from purse seine vessels at West Beach off northwest Whidbey Island.

The nonsalmonid fishes used, except the shiner perch (*Cymatogaster aggregata*), are commonly taken incidentally by Washington salmon anglers. Average lengths (Table 1) were weighted by the number of anglers attempting to identify the various sized specimens. The minimum legal total length for Washington sport-caught salmon is 16 inches (37 cm FL) on Puget Sound and 20 inches (46 cm FL) off the coast and on western Juan de Fuca Strait.

The salmon were dressed as soon as practical, by removing viscera and gills without severing the isthmus. Care was taken to keep scales intact. The other fishes were not dressed. Specimens not used immediately were wrapped in plastic and aluminum foil and stored in a freezer. The nonsalmonid fishes were often collected on the day of the survey. Specimens were used a maximum of two days and were kept on ice during this period.

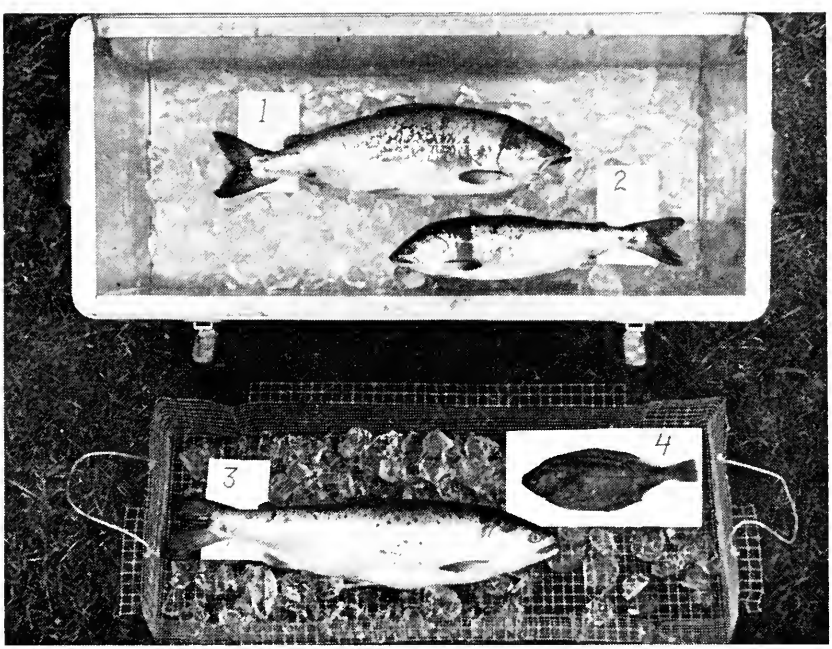

FIGURE 1—Typical display of survey specimens. *Photograph by Ronald E. Allen.*

Equipment

The survey specimens were displayed from a portable ice chest 28 by 11 inches by 13½ inches deep, inside dimensions. To display the fish to survey participants, a tray containing half of the fish was removed from the chest (Figure 1). Each specimen was marked with a tag bearing a number from one to four. The displays always involved four fish; three were any combination of chinook and coho salmon and one was a nonsalmon.

Survey

Subjects were approached and asked: "Would you care to participate in a survey the Department of Fisheries is conducting on identification of different kinds of fish?" Nearly everyone approached was willing to participate. Individuals and groups of not more than six persons at a time were involved.

Participants were directed to the display and given a 3- by 5-inch card with the numbers one through four on it. All cards given to any one group were numbered in either red or blue ink. All participants were then told: "In this ice chest, I have four fish displayed and numbered one through four, corresponding to the numbers on the card you were given. I would like you to look over these fish and try to identify them. These fish were all caught in Puget Sound and they may or may not be all the same kind of fish. You may handle the fish if you wish. May I caution you that I want only unbiased information, so please write your most precise answers on your card without making any comments."

About half of the participants, on each day of the survey, responded on red-numbered cards and were given a clue to identification: "Chinook salmon, also called blackmouth, have the teeth of their lower jaw protruding from all black gums." The clue was then repeated once. The other participants, responding on blue-numbered cards, were not given the clue.

The cards were collected as the subjects finished the survey. If any irregularities arose, such as someone talking so as to bias the answers, the affected responses were discarded.

RESULTS

The frequencies with which various names were used were tabulated (Table 1). Different spellings or abbreviations of a single name are not included. Each of the four responses by individual participants is tabulated. "No response" means the numbered space on a card representing a specimen was left blank.

Chinook Salmon

Names used by the respondents and judged as reflecting recognition of this species were: blackmouth, king, chinook, and tyee. "Blackmouth" is a local term for immature chinook salmon. The name "chinook" comprised only 10.0% of the correct responses (Table 2). Had the survey included sites adjacent to Georgia Strait, undoubtedly the name "spring" would have been encountered and considered correct.

The percentages of correct responses with and without the identification clue were 69.7 and 52.9%, respectively (Table 2). The difference is statistically significant ($\chi^2 = 36.83$, with 1 d.f.). In judging responses involving chinook and coho salmon, the terms "salmon" and "jack salmon" were considered neither correct nor incorrect.

TABLE 2

Effects of the Chinook Salmon Identification Clue on Participants' Ability to Recognize Chinook and Coho Salmon

Responses	Number of responses			
	Chinook salmon		Coho salmon	
	Clue	No clue	Clue	No clue
Correct	431 (69.7%)	328 (52.9%)	381 (57.0%)	401 (59.6%)
Incorrect	187 (30.3%)	292 (47.1%)	288 (43.0%)	272 (40.4%)
(Wrong answers)	(125)	(219)	(190)	(187)
(No response)	(62)	(73)	(98)	(85)
Totals	**618 (100.0%)**	**620 (100.0%)**	**669 (100.0%)**	**673 (100.0%)**
Identified as "salmon" or "jack salmon"	23	53	23	48
Grand totals	**641**	**673**	**692**	**721**

Coho Salmon

Names judged as reflecting recognition of this species were: silver, silver jack, hooknose, and coho. The name "coho" comprised only 0.9% of the correct responses (Table 1). The percentages of correct responses with and without the chinook salmon identification clue were 57.0 and 59.6%, respectively. This difference is not significant ($\chi^2 = 0.99$ with 1 d.f.) (Table 2).

The smallest coho salmon used (18 cm FL) was included in a display with a 36 cm FL coho and a chinook salmon. The 68 participants examining these fish correctly identified the smaller coho 16 times and the larger coho 41 times. This small coho was called a "herring" 10 times and a "smelt" twice. The next smallest coho (25 cm FL) was also displayed with another larger coho (41 cm FL). The third salmon was again a chinook. Two hundred participants were shown these salmon and correct identifications were again related to size: small coho—83; large coho—127. Survey participants had significantly more difficulty identifying these two smaller fish than the larger coho ($\chi^2 = 38.77$, with 1 d.f.).

Other Fishes

Names used and judged as reflecting specific recognition of the nonsalmonid fishes (Table 1) were: rockcod for copper rockfish; lingcod and ling for lingcod; sanddab for Pacific sanddab; bullhead for Pacific staghorn sculpin; pogie and shiner for shiner perch; sablefish for sablefish; cod and true cod for Pacific cod. On this basis, 21.5% of the

responses for nonsalmonid fishes were correct. Only 70 of these 909 responses were uses of names recommended by the American Fisheries Society (1960): 68 for lingcod and 2 for sablefish.

CONCLUSIONS

1. Marine salmon angling regulations in Washington, varying by species, would be impracticable without improving general proficiency in species recognition.
2. Washington anglers are capable of improving their ability to recognize salmon species with relatively little instruction.
3. Washington anglers appear to have more difficulty identifying coho salmon less than 26 cm FL than larger coho.
4. The results of this survey cast doubt on data Clark (1962) may have obtained from Washington marine anglers regarding the identity of their catches.
5. Participants in this survey infrequently used common names recommended by the American Fisheries Society (1960) for all species involved, except lingcod (*Ophiodon elongatus*).

REFERENCES

American Fisheries Society. 1960. A list of common and scientific names of fishes from the United States and Canada. Amer. Fish. Soc., Spec. Publ. No. 2, 2nd ed. 102 p.

Clark, John R. 1962. The 1960 salt-water angling survey. U.S. Fish and Wildl. Serv., Bur. Sport Fish. and Wildl., Circ. 153, iv + 36 p.

Hagerman, Fred B. 1951. An easy method of separating king and silver salmon. Calif. Fish and Game, 37 (1) : 53–54.

Ryan, James H. 1959. California inland angling estimates for 1954, 1956, and 1957. Calif. Fish and Game, 45 (2) : 93–109.

Seeley, Charles M., Robert C. Tharratt, and Richard L. Johnson. 1963. California inland angling surveys for 1959 and 1960. Calif. Fish and Game, 49 (3) : 183–190.

Calif. Fish and Game, 54 (1) : 49–57. 1968.

TWO FISHES AND A MOLLUSK, NEW TO CALIFORNIA'S MARINE FAUNA, WITH COMMENTS REGARDING OTHER RECENT ANOMALOUS OCCURRENCES[1]

ALEC R. STRACHAN, CHARLES H. TURNER,
and CHARLES T. MITCHELL
Marine Resources Operations
California Department of Fish and Game

The purple brotula (*Oligopus diagrammus*), rainbow scorpionfish (*Scorpaenodes xyris*), and blunt-knobbed scallop (*Lyropecten subnodosus*) are reported as new to California's marine fauna. Morphometrics are given, and keys to the California genera of Brotulidae and Scorpaenidae are presented.

A white gorgonian (*Lophogorgia cf. chilensis*) and a sponge (*Mycale bellabellensis*) are recorded to extend their known range, while the club-spined urchin (*Eucidaris thouarsii*) is reported as the second specimen from southern California.

INTRODUCTION

Each year numerous noteworthy marine animals are recorded from southern California waters by the staff of the California State Fisheries Laboratory at Terminal Island. The following report discusses six species that were noted in areas outside their previously known ranges: two fishes, a scallop, a sea urchin, a gorgonian, and a sponge.

Except for the club-spined urchin (which was recorded once before in southern California waters), all represent lengthy range extensions; and three, two fishes and a mollusk, are new to California's marine fauna. We presume the five southerners originally were brought north during the warmwater years (1957–60) discussed by Radovich (1961) or during an earlier influx of warm water from the south. The northerner (the sponge) is possibly within its normal range or may have come south during a recent coldwater period.

OLIGOPUS DIAGRAMMUS (HELLER AND SNODGRASS, 1903), PURPLE BROTULA

Four purple brotulas (Figure 1) were caught by California Department of Fish and Game biologist-divers in 60 feet of water in a cave near Fish Hook, San Clemente Island, California (lat. 32° 50′ N., long. 118° 21.5′ W.). Three were collected on February 24, 1966, and the fourth on May 27, 1966. All were captured by using a respiratory poison, "Chem-Fish Collector".

The *O. diagrammus* caught on May 27 was kept alive in an aquarium for 2 weeks. During this time, Jules M. Crane, Jr., of Cerritos College injected it with 0.1 cc of adrenalin to see if luminescence could be induced. It did not luminesce but "bleached" from a normal dark

[1] Submitted for publication June 1967. This work was performed as part of Dingell-Johnson Project California F-22-R, "Environmental and Behavioral Studies of Coastal Sport Fishes", supported in part by Federal Aid to Fish Restoration funds.

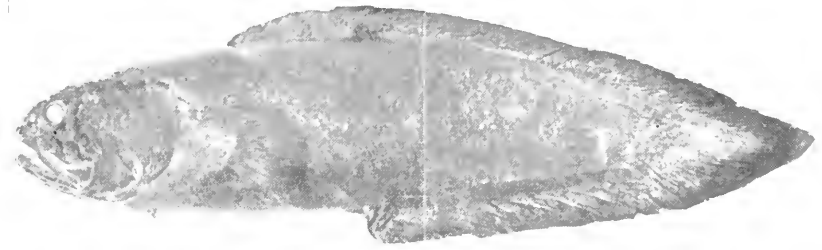

FIGURE 1—Purple bratula, *Oligopus diagrammus*, captured in 60 feet of water off San Clemente Island, California, February 1966. *Photograph by Jack W. Schott.*

purplish-brown to a pale pink, making its two lateral lines more apparent. Twenty-four hours later it regained its natural color.

In his review of the genus, Cohen (1964) mentions the known records for *O. diagrammus* and extends their range from the Galapagos Islands (original description) to Guadalupe Island and southern Baja California. Our San Clemente Island specimens extend its distribution an additional 250 miles northward.

Cohen's study material ranged from 34.5 to 184 mm SL. Our specimens, 35 to 120 mm SL, fall within this size range and agree with his in all respects. However, in view of the small number of known specimens, we are presenting certain measurements and counts (Table 1). These were taken from the left side whenever possible and follow Hubbs and Lagler (1964). Some of the meristic counts were taken from X-rays.

TABLE 1

Measurements and Counts of the Three San Clemente Island *Oligopus diagrammus*

Measurements*			
Standard length	35.0	101.0	120.7
Depth at dorsal origin	219	238	218
Predorsal length	296	290	275
Preanal length	439	465	459
Head length	286	267	247
Greatest head width	123	120	129
Snout length	57	53	47
Bony orbital width	37	39	36
Maxillary	134	121	119
Greatest maxillary width	50	42	44
Counts			
Dorsal rays	109	111	107
Anal rays	79	81	83
Pectoral rays	25	29	left side 27 right side 29
Vertebrae	51	53	50

* Standard length in mm, all other measurements expressed per mille SL.

Our largest specimen (120 mm SL) had five winter rings on its otolith (John E. Fitch, pers. comm.), which indicates a 1961 hatching. Our collection of this and smaller individuals, including one that was 35 mm SL, indicates *Oligopus* is probably reproducing in southern California waters. Since fertilization is internal with this species, the

chances of establishing breeding colonies in these normally cooler northern (for them) waters are considerably enhanced.

Although they may become well established and numerous, it is doubtful that many will be collected; they are quite retiring and secretive. Those that we collected were inside an underwater cave and either far back in small crevices or in large (basketball-sized) coral heads. They appear easily confused by light and quickly retreat from it.

Since the addition of *Oligopus* to our fauna brings to five the number of brotulid genera in our waters, we have constructed a key to aid future workers in their identification.

1a. Pelvic fins absent ..... *Lamprogrammus*
1b. Pelvic fins present 2
2a. Pectoral rays arranged in two groups, several of the lower ones being separate and much produced (filamentous) ..... *Dicrolene*
2b. Pectoral rays not as above 3
3a. Dorsal and anal fins distinct from caudal fin ..... *Brosmophycis*
3b. Dorsal and anal fins not distinct from caudal 4
4a. One lateral line ..... *Catacyx*
4b. Two lateral lines ..... *Oligopus*

We also propose purple brotula as the common name for *Oligopus diagrammus*, drawing attention to its coloration as a recognition aid.

The three purple brotulas collected in February 1966 have been deposited in the fish collections of the Los Angeles County Museum of Natural History (LACM 8981-1).

SCORPAENODES XYRIS (JORDAN AND GILBERT, 1822), RAINBOW SCORPIONFISH

On May 27, 1966, we collected a single *S. xyris* (Figure 2) from a cave in 60 feet of water near Fish Hook, San Clemente Island, California (lat. 32° 50′ N., long. 118° 21.5′ W.). It was stunned with "Chem-Fish Collector" and netted as it drifted from its hiding place in a crevice. Subsequently we observed, but did not collect, several

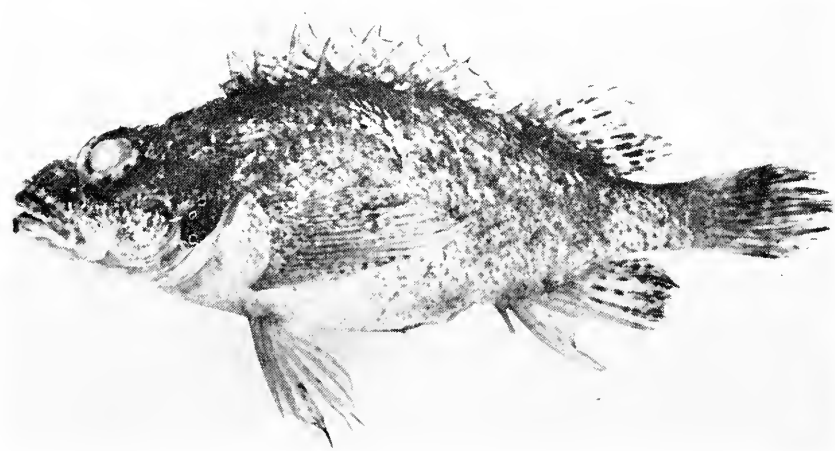

FIGURE 2—Rainbow scorpionfish, *Scorpaenodes xyris*, captured in 60 feet of water off San Clemente Island, California, May 1966. *Photograph by Jack W. Schott.*

additional specimens at San Clemente Island: 1 near Pyramid Light, September 26; and 13 near Mosquito Anchorage, 7 on November 28 and 6 on December 8, 1966. These fish were all approximately 5 inches long. All were hiding in crevices and caves at 60- to 80-foot depths.

On March 21, 1967, we collected a *S. xyris* at Isthmus Reef, Santa Catalina Island, California (lat. 33° 27′ N., long. 118° 29′ W.). We employed quinaldine to stun this fish, netting it as it floated out of its hiding place in a small cave, 80 feet beneath the surface. It was still alive in an aquarium at the California State Fisheries Laboratory 60 days later.

The rainbow scorpionfish is new to the marine fauna of California, our collections having extended its range some 250 miles northward from Guadalupe Island. It had previously been collected from the Gulf of California south to Ecuador (Boyd W. Walker, pers. comm.) and possibly to Peru (Nichols and Murphy, 1944). Carl L. Hubbs (pers. comm.) has collected several *S. xyris* from Guadalupe Island and reports all were larger than individuals found in the Gulf of California. In keeping with this trend, our 5-inchers are also larger than the 1½- to 3½-inch specimens typically collected throughout the Gulf. In all other respects, our specimens are similar to those previously recorded.

Our San Clemente Island fish was a female with egg-filled ovaries, indicating a summer spawning. This is opposed to the winter-spring spawning typical of other local scorpaenids. This specimen exhibited 13 winter rings on its otolith (John E. Fitch, pers. comm.), suggesting

TABLE 2

Measurements and Counts of the San Clemente Island *Scorpaenodes xyris*

Measurements*	
Standard length	125.7
Head length	373
Bony interorbital width	058
Snout length	111
Bony orbital width	104
Bony suborbital width	036
Maxillary	177
Least depth of caudal peduncle	101
Ventral peduncle length	171
Dorsal peduncle length	115
Anal fin base	154
Pectoral fin base	125
Longest pectoral ray, 10th ray	288
Longest ventral ray, 2nd ray	235
Length of ventral fin spine	178
Longest dorsal fin spine, 4th spine	134
Longest anal fin spine, 2nd spine	215
Counts	
Dorsal rays (X-ray shows last ray branched)	XII, I-10
Anal rays (X-ray shows last ray branched)	III-6
Pectoral rays (all simple)	19
Ventral rays	I-5
Vertebrae	25
Gill rakers outer arch, total	20
Upper limb	6
Lower limb	14
Pored lateral line scales	approximately 45–48
Sex	female
Stomach contents —(remains of one shrimp)	

* Standard length in mm, all other measurements expressed per mille st.

that it hatched about 1953, before the warmwater years of 1957-60. Because of its secretive habit (living in crevices and caves) and its similarity in appearance to juvenile sculpins (*Scorpaena guttata*), it may have been overlooked in prior collecting at these offshore islands.

The addition of *Scorpaenodes xyris* to our fauna brings to four the scorpaenid genera found in California, so we are presenting certain counts and measurements for our San Clemente Island fish (Table 2) and have constructed a simple key to aid other workers in separating these genera.

1a. Dorsal fin spines typically 12, vertebrae 24 ..... *Scorpaena*
1b. Dorsal fin spines typically 13 or more, vertebrae 25 or more 2
2a. Dorsal fin spines 15 or 16, vertebrae 29 ..... *Sebastolobus*
2b. Dorsal fin spines typically 13, vertebrae 25–27 3
3a. Palatines present ..... *Sebastodes*
3b. Palatines absent ..... *Scorpaenodes*

We propose rainbow scorpionfish as the common name for this species, drawing attention to its polychromatic coloring as a recognition aid.

The *S. xyris* collected on May 27, 1966, has been deposited in the fish collections of the Los Angeles County Museum of Natural History (LACM 8921-1).

LYROPECTEN SUBNODOSUS (SOWERBY, 1835), BLUNT-KNOBBED SCALLOP

During September 1963, two living *Lyropecten subnodosus* were collected by Richard Anderson of Los Angeles. Both were taken in 125 feet of water off Long Point, Santa Catalina Island, California (lat. 32° 24′ N., long. 118° 22′ W.). The shells measured 155 and 150 mm high, 156 and 152 mm wide, and 82 and 76 mm through the valves, respectively. The 150-mm shell exhibited three and possibly four "growth" rings, with some additional marginal increment (Figure 3).

On February 26, 1967, a third living *L. subnodosus* was collected at Cherry Cove, Santa Catalina Island, California (lat. 33° 27′ N., long. 118° 30′ W.) by Robert F. Meistrell, co-owner of Dive 'N Surf dive shop, Redondo Beach. This scallop was found on the open sand at a depth of 20 to 30 feet. It measured 140 mm high, 149 mm wide, and 62 mm through the valves. Although the smallest of the three specimens, it had 8 and possibly 9 "growth" rings. If these rings are indeed annual, all three scallops arrived as larvae sometime between 1958 and 1960, the warmwater years discussed by Radovich (1961).

Grau (1959) gives the geographical distribution of this species as western Baja California, Scammon Lagoon to Cape San Lucas, and from the Gulf of California to Negritos, Peru. He records its bathymetric range as low tide into depths of 60 fathoms. Finding these bivalves at Santa Catalina Island extends their range some 400 miles northward.

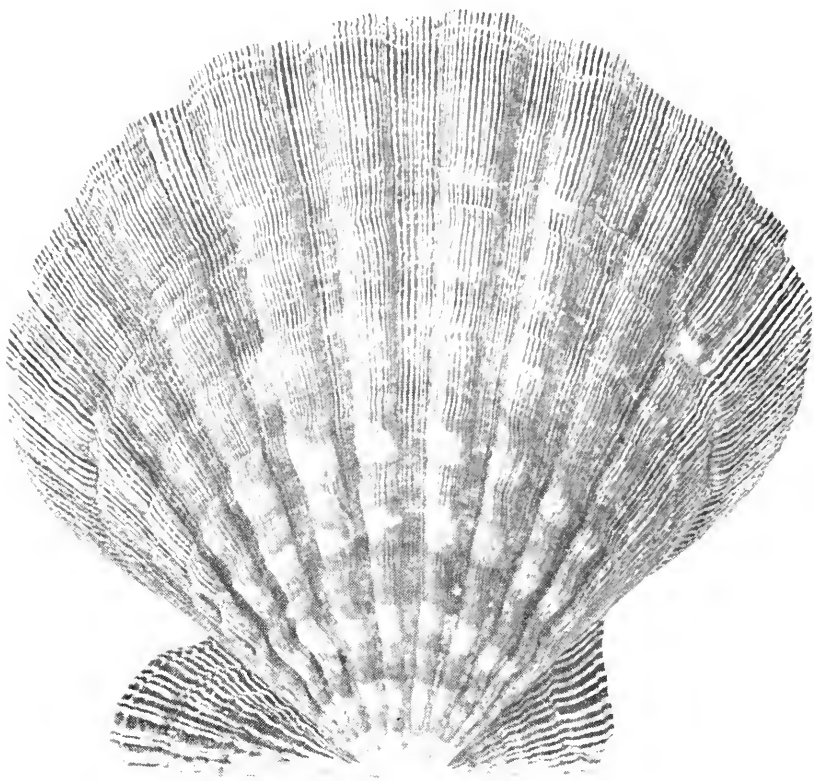

FIGURE 3—Blunt-knobbed scallop, *Lyropecten subnodosus*, from 125 feet of water off Santa Catalina Island, California, February 1967. *Photograph by Jack W. Schott.*

We have no information regarding their ability to reproduce here; the flesh had been removed from the shells when we examined them. Scallops of these proportions would be a welcome addition to California's marine fauna if a population of harvestable size became established.

LOPHOGORGIA CF. *CHILENSIS*, WHITE GORGONIAN

On October 29, 1963, California Department of Fish and Game biologist-divers collected an unusual white gorgonian (Figure 4) in 120 feet of water at Ship Rock, Santa Catalina Island (lat. 33° 27.5′ N., long. 118° 30.5′ W.). Another white gorgonian was picked up on January 9, 1964, off Rocky Point, Palos Verdes Peninsula (lat. 33° 46.5′ N., long. 118° 25.5′ W.) by Robert F. Meistrell. In each instance, the white gorgonian was growing among pink gorgonians, *Lophogorgia chilensis* (Verrill), on a rocky substrate.

In gross morphology and microscopic appearance of the spicules, both white specimens closely resemble this pink species. This pure white color phase, common in the Gulf of California and along the

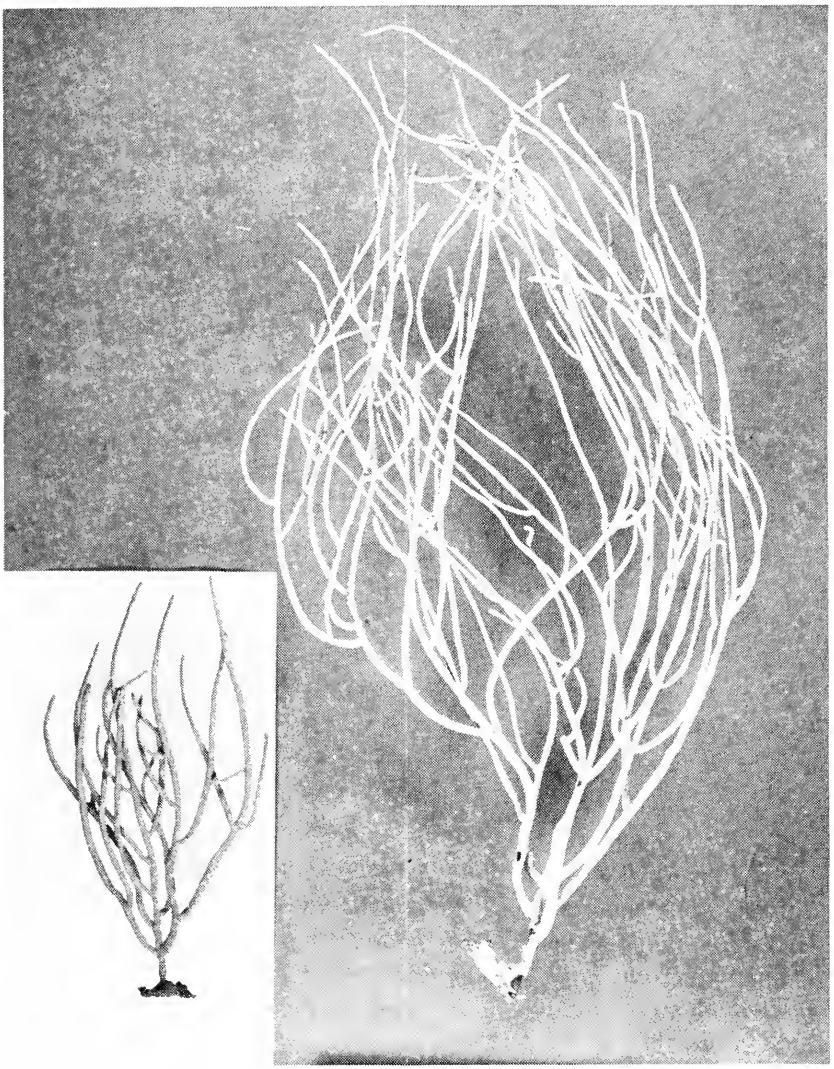

FIGURE 4—White gorgonian, *Lophogargia* cf. *chilensis*, collected in 120 feet of water off Santa Catalina Island, October 1963. The insert specimen is the typical pink form of *L. chilensis*. *Photograph by Jack W. Schott.*

outer coast of southern Baja California, was previously unknown in southern California waters.

A monthly growth of 10 mm has been recorded for *L. chilensis* (C. H. Turner, E. E. Ebert, and R. R. Given, MS), and we assume that the white form grows at a similar rate. Since our two specimens measured 406 and 410 mm, a 10-mm monthly growth rate would make them 40 and 41 months old, respectively. This would indicate their arrival (as pelagic larvae) in June and July 1960, near the end of the warmwater period discussed by Radovich (1961). With the continued use of

SCUBA by sport and scientific divers, we anticipate additional finds of this nature, which should help clarify the nomenclature of pink and white *Lophogorgia*.

MYCALE BELLABELLENSIS (LAMBE, 1905), SPONGE

On November 15, 1966, the purse seiner *St. Anthony* snagged an unusual funnel-shaped sponge, *Mycale bellabellensis*, on Dago Bank off Long Beach, California (lat. 33° 38′ N., long. 118° 11.5′ W.), where the depth was approximately 10 fathoms. The largest piece of this sponge, 28 cm high and 18 cm in diameter, was brought to us for identification.

De Laubenfels (1932) reports the type locality of *M. bellabellensis* as off the west coast of Canada and mentions other specimens from Monterey Bay, California. He lists its bathymetric range as 50 to 800 meters (25 to 400 fathoms). Ujita (1965) reported 10 of these sponges from northwest of Cape Mendocino (lat. 40° 34′ N., long. 124° 35′ W.) in 70 to 80 fathoms of water. The *St. Anthony* collection extends the known range of *M. bellabellensis* some 280 miles southward from Monterey Bay. We believe southern California is possibly within the normal range for this sponge. Failure to "find" it until now may be due to inadequate collecting in this area.

EUCIDARIS THOUARSII (VALENCIENNES, 1846), CLUB-SPINED URCHIN

On December 29, 1963, Robert F. Meistrell collected a club-spined urchin while he was diving in 30 feet of water in Emerald Bay, Santa Catalina Island (lat. 33° 28′ N., long. 118° 31.5′ W.). It was living in a deep fracture of a solitary rock which was surrounded by sand and was wedged in so tightly its test had to be broken to get it out. Meistrell sent the fragment of this urchin to California State Fisheries Laboratory, where it was identified as *Eucidaris thouarsii,* the second specimen recorded from southern California waters.

The other club-spined urchin (Fitch, 1962) was collected off St. Catherines Bay, Santa Catalina Island, in 70 feet of water and set a new size record for the species.

ACKNOWLEDGMENTS

We wish to thank the many people who helped make this report possible. We are particularly indebted to the boat crews of the California Department of Fish and Game patrol boats *Broadbill, Bluefin,* and *Marlin,* who transported us to various diving localities. We are also grateful to Earl E. Ebert, Robert R. Given, Daniel W. Gotshall, and John H. Prescott for their diving and collecting assistance. We are grateful to Robert F. Meistrell, co-owner of Dive 'N Surf, Redondo Beach, for the three specimens he gave us. Meistrell is an expert diver and a discerning collector of marine fauna who demonstrates a keen awareness of our local biota and specimens which are unusual in this area.

We wish to thank: Robert J. Lavenberg for the fish X-rays; John E. Fitch for identifying some of the specimens, determining ages of the fishes, and constructive criticism of our manuscript; and Jack W. Schott for the photography.

REFERENCES

Cohen, Daniel M. 1964. A review of the ophidioid fish genus *Oligopus* with the description of a new species from West Africa. Proc. U.S. Natl. Mus., 116 : 1–22.

De Laubenfels, M. W. 1932. The marine and fresh-water sponges of California. Proc. U.S. Natl. Mus., 81 (4) : 1–140.

Fitch, John E. 1962. A sea urchin, a lobster and a fish, new to the marine fauna of California. Calif. Fish and Game, 48 (4) : 216–221.

Grau, Gilbert. 1959. Pectinidae of the eastern Pacific. Allan Hancock Pac. Exp., 23 : 1–308.

Hubbs, Carl L., and Karl F. Lagler. 1964. Fishes of the Great Lakes region. Univ. Mich. Press, Ann Arbor, 213 p.

Jordan, David Starr, and Barton Warren Evermann. 1898. The fishes of north and middle America. U.S. Natl. Mus. Bull., (47) : 1241–2183.

Keen, A. Myra. 1958. Sea shells of tropical West America. Stanford Univ. Press, 624 p.

Nichols, John Treadwell, and Robert Cushman Murphy. 1922. On a collection of marine fishes from Peru. Bull. Amer. Mus. Nat. Hist., 46 (9) : 501–516.

— 1944. A collection of fishes from the Panama Bight, Pacific Ocean. Bull. Amer. Mus. Nat. Hist., 83 (4) : 221–260.

Phillips, Julius B. 1957. A review of the rockfishes of California (Family Scorpaenidae). Calif. Dept. Fish and Game, Fish Bull., (104) : 1–158.

Radovich, John. 1961. Relationships of some marine organisms of the northeast Pacific to water temperatures, particularly during 1957 through 1959. Calif. Dept. Fish and Game, Fish Bull., (112) : 1–62.

Ujita, Hideto Kim. 1965. Unusual sponge found off northern California coast. Calif. Fish and Game, 51 (3) : 218–219.

BOOK REVIEWS

A Sand County Almanac

By Aldo Leopold; Oxford University Press, New York, 1966; xv + 269 p., illustrated. $6.50.

This book is a reissue of *A Sand County Almanac* but includes eight essays from *Round River*. Some minor revisions have been made in the original text "where dated references served only to distract the reader". This neat little volume is attractively illustrated by Charles W. Schwartz.

Leopold was a rare individual with a unique appreciation of the natural environment and the ability to express this appreciation in the written word. The result is pleasant to read. However, all will not be pleasure in reading this book. The destruction of the natural environment in the face of advancing development of civilization is pointed out loud and clear. Certainly since Leopold's death in 1948 this destruction has proceeded at an accelerated pace.

Groups and individuals interested in preserving the natural environment need all the ideas and ammunition they can muster in getting their ideas across to governmental and policy making bodies. *A Sand County Almanac* is an excellent source.—*C. M. Ferrel.*

California Natural History Guides

University of California Press, Berkeley and Los Angeles.

Through 1966, 20 authoritative little paperbound booklets have been published in this continuing series, covering a multitude of subjects from geology and weather through trees, butterflies, and mammals. Some of these contain as few as 64 pages (not counting the 8 pages of color pictures in each), while others exceed twice that number. Prices range from $1.50 to $4.95 each.

The intent of the series is to familiarize the reading public with details regarding our natural heritage: species, environment, ecology, natural history, laws and regulations, conservation, etc., and to aid one in identifying and interpreting the things we see.

Many educational institutions including colleges and universities are using these booklets in classroom instruction because the information they contain is factual, concise, and up-to-date. Text figures (maps, sketches, and shaded drawings) are liberally sprinkled throughout, and each booklet typically contains eight pages of color pictures (photographs or paintings). Several color plates in booklets I have seen should not have been used because the second color run did not fall exactly on the first—the effect is dizzying, to say the least.

Four of the latest booklets called to my attention (others undoubtedly will be published before this review) are entitled *Cacti of California* (64 p.), *The Climate of Southern California* (87 p.), *Seashore Plants of Southern California* (101 p.), and *Seashore Plants of Northern California* (103 p.). All four of these were published in 1966; the one on climate was authored by Harry P. Bailey, and the other three by E. Yale Dawson—certainly among the last manuscripts he completed before his untimely death last year. The booklet on cacti sells for $1.50, while the other three are listed at $1.75 each.—*John E. Fitch.*

Invitation to Archaeology

By James Deetz; The Natural History Press, Garden City, N. Y., 1967; x + 150 p., illustrated. $1.25 paper, $4.50 cloth.

It is high time that fishery biologists and ichthyologists showed a more active interest in archaeology if we are ever to do more than speculate about origins and affinities of present-day fish faunas, if we wish to learn factual details regarding primitive fisheries, or if we are even remotely curious about the world around us. The contents of Indian middens are our only hope for bridging the 10,000-year gap between living fishes and their fossilized ancestors of Pleistocene times. Considering the rate at which Indian village sites are being wiped out, buried, or otherwise

destroyed by our "progressive" modern civilization, the opportunity to make a thoroughly comprehensive study already has passed us by.

Invitation to Archaeology presents "in brief form the essential hows, wheres and whys" of the subject, and is written in an easy-to-understand style. Regardless of one's formal training in the science of archaeology, this handy little book is worth owning for its instructiveness or as a refresher course.—*John E. Fitch.*

Poisonous and Venomous Marine Animals of the World

By Bruce W. Halstead; United States Government Printing Office, Washington, D.C., 1965 [to 1968?], three volumes. $50.

Few scientists are able to garner enough knowledge in a lifetime to produce a treatise such as this, and even fewer have the ability to write lucidly and meaningfully of their work. Apparently neither of these was an insurmountable obstacle to Bruce Halstead, nor was he lacking in "drive", a necessary ingredient for completing such a task.

Although the first volume in this monumental series carries the publication date of 1965, I do not know of anyone who received a copy until several months of 1966 had passed. Publication of the second volume (on fishes) has been delayed until the fall of 1967 (it should be out before this review), and I am told the final part (involving fishes, sea snakes, polar bears, etc.) will be forthcoming during 1968. None of the volumes can be purchased separately—the $50 "subscription" price includes the set of three.

Volume 1, a beautifully-bound book measuring 9 by 12 by 2½ inches, comprises 994 pages, and covers the various phyla of marine invertebrates which contain venomous or poisonous members. The first 157 pages are devoted to the "History of marine zootoxicology" from medieval times to the present. It makes very interesting reading, and is liberally sprinkled with illustrations. In a section of this entitled "An annotated list of contemporary workers in marine biotoxicological research", Dr. Halstead has provided a photograph of each individual, and a brief biographical sketch.

For each phylum, a compendium of information is routine. Lists of reportedly toxic species are followed by lists of suspect species, and there are narrative accounts dealing with the history of research, biology of organisms involved, mechanisms of intoxication, medical aspects, public health aspects, etc. The data for each phylum are fully documented, and page after page of exquisite photographs, paintings, and sketches (many in color) have been used to illustrate details of topography, structure, and anatomy of toxic organisms, and, in many cases, the havoc they wreak upon victims of their toxins.

I anxiously await the arrival of volumes two and three, and heartily recommend that those who have not yet purchased a set do so immediately. I would not like to take the chance that the "treatise" will be reprinted once the initial supply has been exhausted.—*John E. Fitch.*

Fishes of the Atlantic Coast of Canada

By A. H. Leim and W. B. Scott; Fisheries Research Board of Canada, Ottawa, 1966; Fisheries Research Board of Canada Bulletin No. 155, 485 p., illustrated. $8.50.

The "nearly 300 species" of marine fishes inhabiting the Canadian Atlantic coastline (approximately 21,000 miles) seaward to approximately the 1,000-fathom curve are discussed in this volume. Species accounts generally include English and French common names (the English common names are not always identical to those recommended by the American Fisheries Society), scientific names, descriptions, and natural history data including size, color, distribution, biology, and economic importance. Identification keys are scattered throughout the volume; those to major groups appear early, while generic and specific keys are conveniently placed with appropriate families.

Drawings (some more artistic and accurate than others) are given for 2 cyclostomes, 27 elasmobranchs, 3 chimaerids, and 204 teleosts, and there are four color plates. Some pictures are erroneous and others have not been placed where they should be, especially those of the myctophids.

Some of the biologic information badly needs updating, and the overall quality of the text appears to be below the capabilities of either author. This probably is a reflection of the break in continuity resulting from the death of Dr. Leim (who was preparing the book) in 1960 and the completion of the book by Dr. Scott, who

had little opportunity to do a comprehensive revision in his own style because of time limitations placed upon him.

Regardless of these drawbacks, the volume bridges a long-standing gap in our knowledge of Canadian Atlantic fishes, and should prove extremely useful to fishery biologists and ichthyologists throughout the world.—*John E. Fitch.*

Modes of Reproduction in Fishes

By Charles M. Breder, Jr., and Donn Eric Rosen; The Natural History Press, Garden City, N. Y., 1966; xv + 941 p., illustrated. $17.50.

The culmination of 33 years of literature research, review, and abstracting, this volume contains a wealth of diversified information pertaining to the reproductive habits of fishes. The primary purpose for compiling the volume was ". . . to amass in one place all the data that have been accumulated on the subject in order to appraise, analyze, and digest them". Coverage includes the classes of Amphioxi, Agnatha, Chondrichthyes, and Osteichthyes. Approximately 1,500 of the presently recognized 20,000 species of fishes are referred to in some degree in the text. A cursory examination will reveal that the detailed information is concentrated on two groups of fishes—those that are the subject of fish-cultural activities and those prized by the aquarist. As stated by the authors, "The material itself is most uneven, and there are great gaps where there simply are no data." Omission of certain references has created a scarcity of data for several important and studied species. Coverage of the reproductive habits is more complete (but understandably general) at the family or subfamily level than at the species level.

Three sections comprise the textual portion of the volume. The systematic section represents the main body of the text. Data are presented ". . . within the framework of current fish classification". Several teleostean groups have been taxonomically rearranged and the resulting classification may be confusing. General statements of the reproductive habits of families, and in many cases subfamilies, are followed by more detailed data pertaining to individual species. Species data concerning breeding season, breeding site, migration, secondary sex characters, sex discrimination, competition for mates, courtship, mating, and parental care are presented. Comprehensive discussions of all the areas of treatment for any single species are infrequent.

The second section summarizes the modes of reproduction for the broad groups of Agnatha, the nonteleost gnathostome fishes, and the teleost fishes. For the latter group, generalizations are made within the topics of mating associations, mating habits and breeding sites and migrations, egg types and parental care, and secondary sexual characters and mating patterns.

The third section consists of 58 pages of charts comparing the fish families on the basis of secondary sex characters, mating, breeding sites, products, parental care, and migration. Comparison can be made between chief reproductive characteristics and current concepts of morphological relationship.

Approximately 4,000 references are included in the 231-page bibliography. The systematic index is extensive and greatly facilitates the use of the text. Unfortunately, the printing and binding are of substandard quality, especially considering the relative high cost of the volume. The authors have accomplished a remarkable task in compiling this volume. However, attempting such a broad subject appears to have been deleterious to the intended result.—*Keith R. Anderson.*

Fisheries Year Book and Directory 1966–67

Edited by Harry F. Tysser; British-Continental Press Ltd., London, 1966; 467 p., illustrated. $6.

The 1966–67 edition of the *Fisheries Year Book and Directory* contains an international reference and directory compiled for firms engaged in the fishing industry and fishing trades. Information on approximately 90 varieties of market fish and over 6,000 contributing firms is presented.

A world fisheries survey of 30 major fishing nations provides the background for the editorial and reference material that follows. Catches, product production, and fishing fleet status are included in the survey.

The editorial chapters present a summary of developments in the preservation, selling, and quick-freezing of fish, fish meal, and oil, as well as an international survey of new fishing vessels and equipment. A chapter highlighting fisheries research in the United Kingdom is also included.

Reference chapters cover a dictionary of fish names in eight languages, a fish supply calendar, and listings of organizations and trade associations, trade journals, and fishing vessels completed or on order in 1965.

In the directory section, listings are provided, by national origin, of firms engaged in exporting, canning, manufacturing by-products, supplying machinery and equipment for processing and packing, selling ship equipment and supplies, providing cold storage, and engaged in transport. A list of newly amended trademarks and brands, and a classified Buyer's Guide are also included.

The wide range of information presented in the *Fisheries Year Book and Directory* makes this book a valuable reference to all people interested in fisheries.—*J. Gary Smith.*

Advances in Ecological Research, Volume 3

Edited by J. B. Cragg, Academic Press, London and New York, 1966; xi + 324 p., illustrated. 80s.

This third volume of the series includes four interesting and useful papers. T. B. Reynoldson describes his field investigations to determine the distribution and abundance of lake-dwelling triclads (Planaria). Manfred D. Englemann evaluates the growth and development of the science of terrestrial energetics, and animal productivity. J. E. G. Raymont reviews what is known about the production of marine plankton. H. Clomp describes the results of his 15-year study on the population dynamics of pine loopers (a moth) in a scotch-pine plantation of Norway.

Each of the papers is well written, interesting, and useful to anyone technically involved with ecology.

In my opinion, this is the best of an outstanding series. Editor J. B. Cragg has done a fine job.—*D. W. Kelley.*

Summer Island: Penobscot Country

By Eliot Porter; edited by David Brower; Sierra Club, San Francisco, 1966; 200 p., illustrated with 48 color and 48 varnished gravure photographs. $25.

In word and picture, Eliot Porter has woven a hauntingly delicate and beautiful account of his long association with the wonderful islands of Penobscot Bay on the Maine Coast. Coming for his first summer on Great Spruce Head Island when he was eleven years old, the author grew and matured with its waters, rocks, plants, and animals and came to know them intimately.

On this island of several hundred acres, which was acquired by his father as the family summer home, interference and manipulations by man have been kept to a minimum for half a century. "There one may watch nature freely manifest herself in the chain of succession from one living form to another, from season to season, and from decade to decade. Birth, germination, growth, and death follow an inevitable sequence."

Porter shares superbly his explorations and experiences in this changing scene. Giving up a teaching career in biochemistry and bacteriology at Harvard, he has won international acclaim as a photographer of nature in color. His first two Sierra Club publications, *In Wilderness is the Preservation of the World* and *The Place No One Knew: Glen Canyon on the Colorado*, have received high critical acclaim and have been considered among the world's most beautiful books.

The Sierra Club is to be congratulated on this lovely addition to its Exhibit Format Series.—*Leo Shapovalov.*

Rising Trout

By Chales K. Fox, Foxcrest, Carlisle, Pa., 1967; 178 p., illustrated. $7.50.

This volume, although similar to the author's previous work, "This Wonderful World of Trout", does not overlap it. The main theme, of course, is fly fishing. Included are discussions of the development of several fly patterns, ways to present wet and dry flies, night fishing for large browns, and the false riser or fish which come up short of the fly. The latter is considered the greatest problem, and presents the grand challenge.

There are several errors in the nomenclature of the mayflies, but, while disconcerting, they do not materially detract from the book.

A good deal of philosophy is expounded in the last several chapters. I thoroughly enjoyed this description of the fly fisherman:

"Let us investigate further this discriminating descendant of Cro-Magnon who waves a fairy wand as he wades in a stream. Involved is a strange paradox, in fact the strangest for any sport and something positively confounding to the nonangler. He sets forth to catch fish, but he does not want to catch them too easily. He likes to catch large ones, but he does not want all of them to be the same size. He does not like to have the experience of fish getting away, but he does not wish to be successful in landing all he hooks. Just because he is after fish does not mean he must kill each in turn as it is reduced to possession. Obviously, necessary requirements in his success formula are a certain degree of failure and considerable uncertainty. The yardstick of success for the serious angler is the degree of personal satisfaction which is realized. He revels in the challenge of natural problems and glories in the solution of some of them; that is angling."

This book, while designed primarily for fly fishermen, will hold the interest of anyone who likes to fish or cares about the habitat in which trout are found.—*Leonard O. Fisk.*

Free For The Eating

By Bradford Angier; Stackpole Books, Harrisburg, Pa., 1966; 191 p., illustrated. $4.95.

This handbook is a down-to-earth summary of the great bounty of wild vegetable foods available from woods and streamside. Campers, amateur naturalists, or anyone, with a little effort, could locate, prepare, and eat one or a number of the wild plant products listed.

The writer suggests and details recipes for 88 wild fruits, 121 dishes from wild greens, 41 treats from roots and tubers, 21 ways to use wild nuts, and 27 brews from wild plants.

He identifies food and beverage plants by common and generic names, and includes sketches to aid in their discovery. Most foods discussed are found where rainfall and growing conditions are optimal, as in the eastern United States or the Pacific Northwest. In other parts of the country, plants of some of the generic groups found in these favored areas exist, but their quality and appeal may differ radically.

This small book, 5 x 8 inches, can be easily carried in the field, and will provide fun and profit to the user.—*Parke H. Young.*

The Earth Beneath the Sea (Revised Edition)

By Francis P. Shepard; The Johns Hopkins Press, Baltimore, Md., 1967. xi + 242 p., illustrated. $6.95.

This is the revised edition of the work published originally in 1959. The revision includes a large amount of developments in the field of submarine geology since the first edition. It covers virtually all facets of the undersea world, from the initial chapter on "Waves and Currents Modify the Sea Floor" to "Using the Present Sea Floor Deposits to Interpret the Past", in Chapter 11. This intriguing and absorbing work is written particularly so that the average person without a technical background in oceanography or geology can understand it. Upon completion of the book one can have an excellent overall picture of submarine geology and oceanography. Dr. Shepard's personal experiences in various areas of the world during his 40 years of marine studies are extremely interesting as he applies them to the theme of the book. The many illustrations and photographs are well done and complement the text. I believe that anyone with an interest in the sea, be it inquiring, aesthetic, or scientific, should read this well-written and informative book—*Hugh L. Thomas.*

Extinct and Vanishing Animals

By Vinzenz Ziswiler [revised English edition by Fred and Pille Bunnell]; Springer-Verlag New York, Inc., New York, 1967; x + 133 p., illustrated. $3.40 (soft cover).

The author has done an excellent job of outlining the problem of extermination of animal faunas, citing examples from throughout the world. Extermination may be direct, as from man's use of the animals as food or from elimination to prevent competition with domestic animals. Direct extermination is the simplest to identify as to cause and solution. Indirect extermination is a very complex problem—facets of which are not thoroughly understood. Of course, indirect extermination is tied in to the various alterations of the environment by man's activities. Some of the most dramatic examples of indirect extermination have occurred in island faunas from the effects of introduction of various exotic animals.

From the subject of destruction of the world's faunas the author takes up various means of reversing the trend and preservation. The author makes a plea for research on natural faunas, pointing out that adequate knowledge to effect preservation is available for but a relatively few species. Wildlife preserves are essential, but the author wisely points out that often some form of habitat and animal management is essential on the preserve area.

Animal forms already extinct and those in greatest danger of extinction are listed in an appendix.

Altogether, this book is an excellent source of information on the problem of preserving the world's faunas.—*C. M. Ferrel.*

Sonar in Fisheries—A Forward Look

By D. G. Tucker; Fishing News (Books) Limited, London, 1967; 136 p., illustrated with photographs and drawings. £ 1 17s. 6d. ($5.20).

The author is a research engineer at the University of Birmingham, specializing in the development of sonar for fisheries and oceanographic work.

The first section reviews the basic theory and operation of acoustic sounders. The capabilities and limitations of ordinary existing equipment are especially stressed. The reader receives a fairly good background in the principles of underwater acoustics, enabling him to comprehend other literature and terms dealing with this subject.

The second section deals with a new sophisticated sonar system which presents an underwater picture in a manner similar to radar. The author is highly optimistic about this system for application to fisheries work. Fish school shapes, sizes, and movements can be accurately displayed, and thorough search of an area can be achieved. The major limitation is a reduced maximum range of detection.

The third and last section looks to the future for the development of new and revolutionary systems that overcome some of the major limitations inherent in the present ones. These advances could result in greatly increased ranges, use of a wide range of frequencies with the same transducer, and a drastic reduction in size and cost of equipment.

The first section can be understood by a reader without a background in electronics, but parts of the second and last section are difficult to grasp in detail. The book would be very useful to anyone using sonar or echo sounding in fisheries work. —*Kenneth F. Mais.*

Illustrated Dictionary of Names of Commercial Fishes from the Western Part of the Pacific Ocean. In Latin, Russian, Chinese, Korean, Vietnamese, Mongolian, Japanese, and English. *(Illiustrirovannyy Slovar' Nazvaniy Promyslovykh Ryb Zapadnoy Chasti Tikhogo Okeana na Latinskom, Russkom, Kitayskom, Koreyskom, V'etnamskom, Mongol'skom, Iaponskom y Angliyskom Iazykakh.)*

Edited by G. U. Lindberg, Tran Kong Tam, Chzhu Shu-pin (Editor-in-Chief), Kim Min Su, and A. Dashidorzhi; Komissiia po Rybokhoziaystvennomu Issledovaniiu Zapadnoi Chasti Tikhogo Okeana (Fishery Research Commission for the Western Area of the Pacific Ocean), Peking, 1964; iv + 601 p., illustrated. Price unknown.

This multilingual dictionary gives the common names of 866 freshwater and marine fishes, belonging to 46 orders and 272 families, of the western Pacific area extending from Bering Strait to lat. 10° N. In spite of the title, this dictionary deals with a considerable number of noncommercial fishes. Each species is illustrated by a line drawing, and the sources of these illustrations are given. Literature consulted is listed in a section of the dictionary. The fishes are arranged and numbered according to Berg's "Classification of Fishes". Extensive cross-indexing allows the reader to ascertain readily the name of each species considered in the dictionary in any of the seven languages. The Chinese, Korean, Vietnamese, and Japanese names are transcribed in the Russian alphabet. This feature is of special value to those unfamiliar with the ideographs used in Chinese and Japanese, and with Korean and Japanese phonetical writing. Unfortunately, no Latin transcription is provided for the Russian, Chinese, Korean, Mongolian, and Japanese languages. In some instances, outdated scientific names have been used by the authors. A limited number of synonyms is listed for some of the species. The number of common names is not very extensive. The dictionary should be of special service to fishery biologists, ichthyologists, translators, fishery literature compilers, and librarians in general. The authors should be congratulated, since their polyglot dictionary provides the scientific community with a very useful tool. *W. L. Klawe.*

75795—800 10-67 5,300 *printed in* CALIFORNIA OFFICE OF STATE PRINTING

POSTMASTER: RETURN REQUESTED
Editor, CALIFORNIA FISH AND GAME
CALIFORNIA DEPARTMENT OF FISH AND GAME
1416 9TH STREET, SACRAMENTO, CALIF. 95814

BULK RATE
U.S. POSTAGE
PAID
Sacramento, Calif.
Permit No. 949