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ANNOTATED BIBLIOGRAPHY ON THE CUTTHROAT TROUT

BY OLIVER B. COPE

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CONTENTS

ABSTRACT

Publication of articles on the cutthroat trout began before the turn of the century, after explorations in the Intermountain Region had brought several forms of the cutthroat to the attention of fishery workers. The present compilation brings together 135 abstracts of papers which deal with the biology, culture, distribution, and management of the cutthroat. Twenty-seven zoological names proposed for the cutthroats are listed, and 70 vernacular names, taken from the literature, are presented.

ANNOTATED BIBLIOGRAPHY ON THE CUTTHROAT TROUT

By Oliver B. Cope, *Fishery Research Biologist*, Bureau of Sport Fisheries and Wildlife

The cutthroat trout, *Salmo clarki* Richardson, was the subject of technical fishery articles before the turn of the century. Explorers and fishery workers first became acquainted with the inland forms of this species at the time of the opening of the Intermountain Region, where the cutthroat was the only native trout. Early explorations and the beginnings of fish culture in the Rocky Mountains were the occasions for the first writings on the cutthroat in fishery journals.

As the years passed, articles on the cutthroat appeared sporadically, while most of the attention of trout researchers and managers who reported in the journals was on the rainbow, brown, and brook trouts. In recent years, interest in the cutthroat has been revived, owing in part to the need for information about management of the species in the face of increasing fishing pressure, reduced water supplies, and the trends toward encouragement of native species in western waters and planting of catchable-size fish. The literature of the past 10 years has enjoyed an upsurge in number of papers dealing with the cutthroat, and the species has attained added importance as a subject for biological investigations. The present bibliography has been prepared to bring together the scattered references on the cutthroat to guide fishery workers concerned with this species.

SCOPE

Articles included here are those considered as adding something to our knowledge of the biology, culture, management, or distribution of the cutthroat. Many papers which mention the species very briefly and check lists or routine planting and distribution reports are omitted from treatment here. Original descriptions of species and subspecies are not necessarily included. In general, the abstracts cover published papers, although a few administrative reports are included because of the value of their data and conclusions. When abstracts or summaries have been included in papers, I have transcribed them here; otherwise I have written the abstracts.

NOTE.—Approved for publication Sept. 3, 1957. Fishery Bulletin 140.

NAMES FOR THE CUTTHROAT

A list of names for the cutthroat has been included in this compilation. Perhaps to no other species of trout have so many names, zoological and common, been applied. The species has occupied a variety of waters and has hybridized to produce various genetic mixtures, races, and color phases which have prompted the creation of new names for the many forms. Miller (1935) recognizes 1 species with 11 subspecies. The literature contains the following specific and subspecific names for the cutthroat; some of them are now in synonymy, and some of the forms are probably extinct: *Salmo alpestris* Dymond, *bathoecetor* Meek, *beardslei* Jordan and Seale, *bouvieri* Bendire, *brevicauda* Suckley, *carinatus* Cope, *clarki* Richardson, *declivifrons* Meek, *eromogenes* Evermann and Nichols, *gairdneri* Jordan and Beardslee, *gibbsi* Suckley, *henshawi* Gill and Jordan, *jordani* Meek, *lewisi* Girard, *macdonaldi* Jordan and Evermann, *mykiss* Jordan and Evermann, *pleuriticus* Cope, *purpuratus* Bendire, *seleniris* Snyder, *spilurus* Cope, *stellatus* Girard, *stomias* Cope, *tahoensis* Jordan and Evermann, *tsuppitch* Girard, *utah* Suckley, and *virginalis* Girard. *Salmo evermanni* Jordan and Grinnell is listed by Miller as being in the cutthroat series.

The following vernacular names for cutthroat trout appear in the literature: Alaska cutthroat, Arkansas trout, black trout, black-speckled trout, black-spotted trout, blueback, bluenose trout, Bonneville Basin trout, brook trout, Clark's salmon, coastal cutthroat, Colorado cutthroat, Colorado River trout, Columbia River trout, Columbia salmon-trout, Crab Creek cutthroat, Cranbrook

trout (cutthroat x Kamloops hybrid), cutthroat trout, cutthroat trout of Utah Lake, flat trout, Gibbs' salmon, great trout of Lake Tahoe, green-back trout, harvest trout, Jordan's trout, Lahontan cutthroat, Lake Tahoe trout, lake trout, Lewis' trout, long-headed trout of Crescent Lake, mountain cutthroat, mulefish (cutthroat x rainbow hybrid), native trout, Piute cutthroat, Piute trout, Platte cutthroat, pogy, porgy, Pyramid Lake trout, redfish, red trout, red-bellied trout, red-sided cutthroat, red-throated trout, Rio Grande cutthroat, Rio Grande trout, river trout, Rocky Mountain trout, salmon trout of Lake Southerland, San Gorgonio trout, short-tailed trout, silver trout, silvery-white salmon-trout, Snake River cutthroat, Southern Rocky Mountain trout, snipe, speckled trout, speckled mountain trout, spotted trout of Lake Southerland, spring trout, tommy, Truckee trout, Utah cutthroat, Waha Lake trout, white salmon, winter trout, yellow-belly, yellowfin trout, Yellowstone trout, Yellowstone cutthroat, and various Indian names.

ANNOTATED BIBLIOGRAPHY

BALL, ORVILLE P.

1955. Some aspects of homing in cutthroat trout. Proc. Utah Acad. Sci., Arts, and Lett., 32: 75–80.

Very little previous work has been done to measure the homing instinct in adfluvial fish. The U. S. Fish and Wildlife Service studied homing in the cutthroat in Yellowstone Lake from 1949 to 1955. Immatures in streams were fin-clipped, and spawners in streams were tagged with Petersen disks. Results from immatures were not conclusive, but only 6 out of 280 repeat spawners returned to streams other than those in which they were originally tagged.

BANGHAM, RALPH V.

1951. Parasites of fish in the Upper Snake River drainage and in Yellowstone Lake, Wyoming. Zoologica, 36, Part 3(16): 213–217.

Parasites of 291 Yellowstone cutthroat are listed; 278 of the fish examined were infested. Sixteen species of parasites are named, and the incidences of several are noted in discussions.

BARRETT, I.

1951. Fertility of salmonoid eggs and sperm after storage. Jour. Fish. Res. Bd. Can., 8 (3): 125–133.

Effects of storage on fertility of salmonoid eggs have been studied. Mature eggs and sperm were stripped into dry sterile jars and stored for varying periods at low temperatures before testing their fertility with fresh genital products. Eggs of the chum salmon, *Oncorhynchus keta*, were stored at temperatures of 2.5° to 5.8° C. for 108 hours with an average infertility of less than 20 percent. The sperm of this species shows a wide variation in its reaction to storage, but may be retained for 36 hours in sterile jars with an average of less than 10 percent infertility. Cutthroat eggs stored 36 hours were 18 percent infertile. Kamloops and cutthroat confirmed the applicability of the technique of transporting eggs and sperm stored together in the absence of water.

BEAN, TARLETON H.

1894a. Life history of the salmon. Bull. U. S. Fish Comm., 12: 21–38.

The red-throated trout, *Salmo mykiss*, is called Clark's trout and Rocky Mountain trout. Discussion of distribution, food-habitat preferences, and habits is given.

1894b. Bibliography of the Salmonidae of Alaska and adjacent regions. Bull. U. S. Fish Comm., 12: 39–49.

Lists several very early papers pertaining to cutthroat trout.

BILTON, T. H.

1952. The creel census of cutthroat trout at Lakelse Lake, 1952. Prog. Reports of the Pacific Coast Stations, Fish. Res. Bd. Can., No. 92, October: 18–20.

Three years of creel-census data were accumulated for cutthroat in the lake and river fishery in the Lakelse drainage. Lake fishing was best in July, during mayfly hatches. The river fishery had moved to the lake by this time. In August and September the majority of fishing was in the lake.

The fishery was probably exploiting less than 10 percent of the catchable stock annually. A heavier fishery would obtain a higher yield, probably over a long period of years.

BILTON, T. H., and M. P. SHEPARD.

1955. The sports fishery for cutthroat trout at Lakelse Lake, British Columbia. Prog. Reports of the Pacific Coast Stations, Fish. Res. Bd. Can., No. 104, November: 38–42.

Since 1950 the Fisheries Research Board of Canada has kept records on cutthroat in Lakelse Lake and Lakelse River. Notes on feeding and spawning are given. The sport fishery is described. About 2,000 cutthroat are taken annually by this fishery. Age III and IV trout have predominated in the catch each year.

Figures on the catch per unit of effort indicate that no severe depletion has occurred in the lake population, but the catches on the river have declined since 1950.

Anglers have removed an average of 7 percent of the lake population anually, and 18 to 31 percent of the river population.

BJORNN, TED C.

1957. A survey of the fishery resources of Priest and Upper Priest Lakes and their tributaries, Idaho. Idaho Fish and Game Dept., Completion Report. 176 pp.

In 1955 a survey of the fishery resources of Priest and Upper Priest Lakes and their tributaries was initiated to determine the factors causing the decline in the number of cutthroat in the lake.

Streams running into the lakes provided adequate spawning sites for both cutthroat and Dolly Varden trout. In streams where brook trout have become abundant, competition for food and space between brook trout and cutthroat is very intense. Competition is less in the lakes.

Of the 93,300 fish caught in 1955 from these lakes, 10 percent were cutthroat, and of the estimated total catch of 111,400 in 1956, 5 percent were cutthroat.

The average rate of catch for cutthroat in the upper lake was 1.02 fish per boat per hour, compared with 0.70 in Priest Lake. The average-size cutthroat caught in 1956 was between 11.1 and 11.2 inches. The body-scale relation appeared to be approximately linear.

Juvenile cutthroat spawned from fish migrating from the lakes were found to spend an extended period of time in the streams before migrating to the lakes. Of the fish collected from Priest Lake in 1956, 38 percent spent 2 years in the streams before migrating, 57 percent 3 years, and 5 percent 4 years. For the upper lake, 6 percent migrated after their first year, 35 percent after their second, and 58 percent after their third. The spawning season begins in April and generally ends July 1. Cutthroat in the Priest Lakes mature predominantly during their fifth year of life. Only a very small number of fish ever spawn a second time.

Diet of the cutthroat consists mainly of insects and some plankton.

An average of nearly 500,000 cutthroat a year, mostly fry, have been planted in the Priest Lake drainage for at least the last 10 years, but less than 1 percent have been returned to the creel.

BLACK, EDGAR C., and ISADORE BARRETT.

1957. Increase in levels of lactic acid in the blood of cutthroat and steelhead trout following handling and live transportation. Can. Fish. Cult., Issue 20, pp. 13–23.

Alterations in the blood levels of lactic acid were investigated in hatchery-raised coastal cutthroat and steelhead trout in the following conditions: (*a*) After transferring from outside ponds to troughs inside the hatchery 60 yards (54.9 meters) away; (*b*) sham transportation run for 2 hours in tank truck; (*c*) holding cutthroat for 40 hours, steelhead for 16 hours, in hatchery troughs before transportation of 2 hours 50 minutes.

The following results were noted: (1) Significant increases in blood lactic acid in both species as a result of minimal handling, i. e., in transporting the fish from outside ponds to inside hatchery troughs; (2) very significant increase in blood levels of lactic acid following sham transportation run for 2 hours in a tank truck, and levels were higher in both species than those observed for lake trout and Kamloops trout in 1955; (3) storage of cutthroat for 40 hours resulted in significant lowering of blood level of lactic acid (range 0.8–17.5 mg. percent) following transportation run of 2 hours 50 minutes. Storage of steelhead trout for 16 hours before the same transportation run of 2 hours 50 minutes resulted also in a lower blood level of lactic acid (range 9.5–88 mg. percent).

BONHAM, KELSHAW, and R. WALTER WILLIAMS.

1948. Effect of population pressure upon rate of growth and food conversion of fingerling cutthroat trout. Prog. Fish-Cult., 10 (1) : 15–18.

Fingerling cutthroat trout in 80-gallon aquariums were fed equal amounts of food per fish; two tanks had 28 fish each, two had 280 fish each. Lengths and weights were determined on four occasions. Crowded fish did not differ significantly from uncrowded ones in growth rate or food-conversion rate.

BROWN, C. J. D., and JACK E. BAILEY.

1952. Time and pattern of scale formation in Yellowstone cutthroat trout, *Salmo clarkii lewisi*. Trans. Amer. Micros. Soc., 71 (2) : 120–124.

Scales from adult and immature Lake Yellowstone cutthroat were studied, and three kinds of scale development noted: (1) Fish completely scaled before their first winter and with annuli on all scales; (2) fish partially scaled before the first winter, some scales without annuli; (3) fish without scales in their first winter, and with no annuli at the end of the first growing season.

BROWN, C. J. D., and CHARLES BUCK, JR.

1939. When do trout and grayling fry begin to take food? Jour. Wildl. Mgt., 3 (2) : 134–140.

Experiments on time of initial feeding were done for grayling and several trouts, including cutthroat. Some cutthroat fry were feeding 14 days after hatching, and all were feeding 23 days after hatching. Little uniformity between species was shown; rainbow began first, brook trout last. Size or presence of yolk sac showed no correlation with initial feeding time.

CALHOUN, A. J.

1944a. Black-spotted trout in Blue Lake, California. Calif. Fish and Game, 30 (1) : 22–42.

Upper Blue Lake is an oligotrophic lake at 8,130-foot elevation in the California Sierra Nevada. The lake has black-spotted trout which spawn in five tributary streams. Spawning time, size of spawners, and age of spawners are discussed.

In 1941 a significant number of the trout which matured sexually failed to ascend a stream to spawn.

Marked trout showed that growth did not take place after spawning, and few spawned a second time.

Heavy annual plants of small fingerlings, coupled with closure to fishing, over a 6-year period, did not increase the number of fish in the spawning runs. It seemed to lead to an overpopulation of fish and a depletion of food.

It appears undesirable to return spent spawners to a lake like Blue Lake.

1944b. The food of the black-spotted trout (*Salmo clarkii henshawi*) in two Sierra Nevada lakes. Calif. Fish and Game, 30 (2) : 80–85.

The black-spotted trout in Upper Blue Lake, a deep granite basin at 8,130-foot elevation, subsisted largely on chironomid larvae and pupae. They failed to utilize the rather abundant population of the minnow, *Rhinichthys oscula*, which competes with young trout for food.

The trout of Heenan Lake, a former grazing meadow at 7,000-feet transformed by a dam into a 25-foot-deep reservoir, subsisted largely on plankton crustacea (daphnia and copepods). The extremely abundant bottom fauna of the littoral zone provided only 17 percent of their food (scuds of the *Gammarus* type); immature chironomids, plentiful in bottom samples, provided less than 9 percent.

Heenan Lake trout were in much better condition than those of Blue Lake, reflecting the relative richness of the two lakes.

CALIFORNIA DEPARTMENT OF FISH AND GAME.

1956. Cutthroat nursery. Outdoor Calif., 17 (6):6–7, 11.

Heenan Lake, on the east slope of the Sierra Nevada in California, was built in the late twenties and stocked with cutthroat (*Salmo clarkii henshawi*) from Alpine County. The fish grew well and egg-taking was initiated. California and Nevada have taken 19 million cutthroat eggs from Heenan Lake for stocking elsewhere. California is attempting to reestablish the cutthroat in its former waters on the east slope.

CARLANDER, KENNETH D.

1950. Handbook of freshwater fishery biology. Wm. C. Brown Co., Dubuque, Iowa. 281 pp.

Contains life history and biological measurements reported in many papers on cutthroat.

1953. Handbook of freshwater fishery biology with the first supplement. Wm. C. Brown Co., Dubuque, Iowa. 429 pp.

Contains life history and biological measurements reported in many papers on cutthroat.

CODE, MARK R.

1950. Cutthroat trout without dorsal fins. Prog. Fish-Cult., 12 (2): 85–86.

Cutthroat without dorsal fins were found in South Fork of Sheep Creek in the Ashley National Forest in Utah in 1936. The coloring of the abnormal fish was darker than that of normal cutthroat in the same stream. Some fish with deformed dorsal fins were found in the same stream.

COPE, E. D., and H. C. YARROW.

1875. Report upon the collections of fishes made in portions of Nevada, Utah, California, New Mexico, and Arizona during the years 1871, 1872, 1873, and 1874. Zoology of the Wheeler Survey, 5: 637–700.

Life history account of *Salmo virginalis*, called lake trout, brook trout, and speckled trout, with account of spawning, feeding, and movements. Angling methods are discussed. A discussion of Rio Grande trout, *Salmo spilurus* and *Salmo pleuriticus*, is presented.

COPE, OLIVER B.

1953a. Chloretone as an anaesthetic for adult cutthroat trout. Prog. Fish-Cult., 15 (1): 35.

Chloretone was successfully used for anaesthetizing adult cutthroat at Yellowstone Lake in 1952. Stock solution was prepared in the laboratory, diluted in the field, and used on cutthroat at a strength of 1: 2,000. Cost of the chloretone is slightly higher than that of urethane.

1953b. Length measurements of Lake Yellowstone trout. U. S. Fish and Wildl. Serv., Spec. Sci. Rept.—Fish. No. 103. 17 pp.

Conversion factors and tables are given for total length, fork length, and standard length of cutthroat from Yellowstone Lake. Comparisons from year to year of average total lengths from the fishery and from spawning runs show that declines in size took place from 1950 to 1952 in the northern part of the lake, where fishing was heaviest.

1955. The future of the cutthroat in Utah. Proc. Utah Acad. Sci., Arts, and Lett., 32: 89–93.

The original cutthroats in Utah, the Utah cutthroat and the Colorado cutthroat, have been replaced by the Yellowstone cutthroat. Three factors threaten the cutthroat in Utah and in other Rocky Mountain States. Construction of dams has blocked spawning runs, and more dams are planned. Rainbow are being planted in cutthroat waters and replacing the cutthroat. Importation of cutthroat eggs from Yellowstone Park has been stopped, eliminating about 45 percent of the supply to Utah.

1956. Some migration patterns in cutthroat trout. Proc. Utah Acad. Sci., Arts, and Lett., 33: 113–118.

Migrating cutthroat trout spawners in Arnica Creek, Yellowstone National Park, were counted, day and night, in 1951. Five-sixths of the total count for the season entered the stream between the hours of 6 p. m. and 7–8 a. m. This nocturnal migration is unusual for salmonid spawners, and is explained by the response of spawners to evening freshets that occur during the season of melting snows.

Lakeward-migrating fry in the same stream were counted, and it was found that 88 percent of the total count from August 1 to 15 moved downstream at night. Nocturnal movements of fry have been observed in other trouts and in salmon, and have been attributed to a negative phototropism.

1957a. Six years of catch statistics on Yellowstone Lake. Trans. Amer. Fish. Soc., 85: 160–179.

Catch statistics on cutthroat in Yellowstone Lake are reported for the years 1950–55. This fishery has only one species, the Yellowstone cutthroat. Hourly distribution of fishing is unusual in that there is practically no fishing before 7 a. m. and there are three peak periods of fishing throughout the day. There is an unusual uniformity of fishing effort among days of the week. Characteristics of the various components of the fishery are described.

Reduction of the daily catch limit from 5 to 3 fish in 1953 did little toward reducing total catch, but a shortened season had a decided effect on reduction of catch.

1957b. Races of cutthroat trout in Yellowstone Lake. U. S. Fish and Wildl. Serv., Spec. Sci. Rept.—Fish. No. 208. pp. 74–84.

Yellowstone cutthroat in tributaries to Yellowstone Lake and in Yellowstone River were studied to determine the existence of races. Tagging showed the association of groups of fish with particular spawning streams, and suggests that each tributary studied has its own race of cutthroat. Migrational patterns in the lake after spawning are quite constant from year to year. Mixing of races takes place in the lake, and each part of the lake appears to contain about the same mixture each year.

Times of migration into 5 streams were examined for 5 years, and 5 different patterns were perceived. The patterns were very constant from year to year.

Differences in mean total length of fish in spawning runs were measured, and significant differences found between streams. The differences may be due to differences in age composition or in growth rate, but are racial, since the same relations occur year after year.

Sizes of eggs and numbers of eggs per female were compared in relation to sizes of fish. Counts and measurements do not suggest that the fish are all of the same race.

1957c. The choice of spawning sites by cutthroat trout. Proc. Utah Acad. Sci., Arts, and Lett., 34: 73–79.

Several environmental factors were examined in stream surveys on six Yellowstone Lake tributaries used by cutthroat trout for spawning. Attempt was made to relate distribution of redds in each stream with factors known to sometimes influence choice of spawning sites. Distribution of the best gravel and presence of waterfalls, log jams, and chemical barriers can account for distribution of nests in most of the streams. No explanation is at hand, with our limited knowledge, to reveal why more spawning did not take place in upstream areas in Chipmunk Creek: spawners shunned what seemed to be ideal spawning territory in middle stretches and used lower sections.

Influences of forest cover and stream gradient on distribution of spawning in streams were studied, but no effects were apparent.

A theory applying to use by migrating spawners of headwater areas by the first part of the migration and downstream sections by the later parts of the run was examined in the light of experience with cutthroat in these streams. Arnica, Chipmunk, and probably Pelican Creek fish support the theory; Clear Creek fish were the only ones appearing to refute the hypothesis.

CRAMER, FREDERICK K.

1940. Notes on the natural spawning of cutthroat trout (*Salmo clarkii clarkii*) in Oregon. Proc. Sixth Pacific Sci. Congress, 3:335–339.

This study at Alsea Hatchery in Oregon was concerned primarily with spawning activities of coastal cutthroat. Time of spawning: spawning migrations were counted from December 5, 1938, to February 17, 1939, indicating a peak in late November and early December. Time of hatching: eggs hatch in 45–50 days. Nature of gravels and nests: eggs were 4–7 inches deep in pea-size gravel. Spawning activity: spawning day and night. Spawning was completed in 2 days. More than one nest per female was built. Eggs removed from nest: proportion of fertile live eggs 90 percent and better at stages up to 17 days. Egg counts: 2-year-old hatchery trout averaged 372.5 eggs per female. Small, wild, resident cutthroat averaged 480, and large, sea-run cutthroat averaged 1,170 eggs per female. Sex ratio: 52 males to 48 females in the spawning run.

DANIELS, T. W.

1952. Two-Ocean Pass, Wyoming. Wyo. Wildl., 16 (6): 4–8.

Two-Ocean Pass, on the Continental Divide in Wyoming, is described geographically, and historical significance of fishing studies there is discussed. This was the route used by cutthroat to enter Yellowstone Lake from the Snake River, according to the author, who cites Evermann.

DAVIS, H. S.

1947. Care and diseases of trout. U. S. Fish and Wildl. Serv., Res. Rept. 12, Third Rev. 98 pp.

Care of trout at the hatchery, including care of ponds and raceways, is treated at some length. This is followed by general discussion of trout foods and methods of feeding, special attention being paid to use of dry products for supplementing fresh meat in the diet. Some consideration is given improvement of brood stock and its practical value.

General discussion of parasites and diseases of trout and their control is followed by detailed account of each disease, including characteristic symptoms, etiology, pathology, and methods of control. Figures include drawings and photomicrographs of the most important organisms that cause trout diseases and their effects on tissues.

Numerous examples of care and diseases of cutthroat trout are used in this report.

1953. Culture and diseases of game fish. Univ. of Calif. Press, Berkeley and Los Angeles. x+332 pp.

Cultural methods applicable to cutthroat and other trouts are discussed, and diseases and parasites, some of which occur in cutthroat, are taken up in detail.

DEWITT, JOHN W., JR.

1954. A survey of the coast cutthroat trout, *Salmo clarki clarki* Richardson, in California. Calif. Fish and Game, 40(3): 329–335.

Distribution of coastal cutthroat in California, morphology, life-history notes, and age distribution are discussed.

DIMICK, R. E., and FRED MERRYFIELD.

1945. The fishes of the Willamette River system in relation to pollution. Oreg. St. Coll. Eng. Exp. Sta. Bull. 20. 58 pp.

Details of distribution of coastal cutthroat in this drainage are given. Two biological phases of the cutthroat are reported for the Willamette system. One is nonmigratory and does not get down to the main stem. The other is migratory and gets at least down to the main stem, and perhaps to the ocean. Migratory fish are larger, growing to 18–20 inches. Spawning and feeding habits are discussed. Relations to pollution are treated.

DIMICK, R. E., and DON C. MOTE.

1934. A preliminary survey of the food of Oregon trout. Oreg. St. Agr. Exp. Sta. Bull. 323. 23 pp.

Insects are the dominant food organisms of cutthroat and rainbow trout in Oregon. Aquatic insects form the bulk of the food. Terrestrial insects are prominent in diet in spring, summer, and fall. Crayfish, small fish, and pieces of dead salmon are important to large trout, while immatures of blackflies and midges are important to small trout in streams. Small trout in lakes eat mainly immature midges and water fleas. Fresh-water shrimps are important to Oregon trout in lakes. Table II has detailed analysis of food of 326 cutthroat trout.

DONALDSON, LAUREN R., and FRED J. FOSTER.

1938. A summary table of some experimental tests in feeding young salmon and trout. Trans. Amer. Fish. Soc., 67: 262–270.

Tables contain many references to diets fed to cutthroat, and effects on the fish.

DONALDSON, LAUREN R., DONALD D. HANSLER, and TERRY N. BUCKRIDGE.

1957. Interracial hybridization of cutthroat trout, *Salmo clarkii*, and its use in fisheries management. Trans. Amer. Fish. Soc., 86: 350–360.

Two races of coastal cutthroat trout (*Salmo clarkii*) were hybridized and resultant first-generation hybrids were compared with parent races. In both laboratory and field studies the hybrids showed evidence of hybrid vigor. Catch of sport fishermen, during two seasons at Echo Lake in Washington, where both parent and hybrid trout were planted, was composed of 3 to 6 times as many fish of hybrid stocks as of parent races.

DYMOND, J. R.

1928. The trout of British Columbia. Trans. Amer. Fish. Soc., 58: 71–77.

Description of cutthroat is given, with notes on distribution. Suggestions for management are advanced.

1931. Description of two new forms of British Columbia trout. Contr. Can. Biol. Fish. N. S., 6 (16): 391–395.

Kamloops and cutthroat trout found at high altitudes in British Columbia differ in so many respects from those occurring at lower levels that it has been found advisable to recognize them as subspecifically distinct. Two new subspecies are therefore described, viz., *Salmo kamloops whitehousei* and *Salmo clarkii alpestris*.

1932. The trout and other game fishes of British Columbia. Can. Dept. Fish., Ottawa. 51 pp.

Structural and color details of cutthroat in British Columbia are described in detail. *Salmo clarkii clarkii*, *S. c. lewisi*, and *S. c. alpestris* are subspecies treated, and a hybrid between Kamloops and cutthroat is briefly discussed. Excellent color plates of coastal and Yellowstone cutthroats are included. Descriptions and life histories include colorations, morphologies, migrations, spawning, and game-fish qualities. Comparisons with steelhead are made for the coastal form.

ECHO, JOHN B.

1956. Some ecological relationships between yellow perch and cutthroat trout in Thompson Lake, Montana. Trans. Amer. Fish. Soc., 84: 239–248.

Relation between yellow perch and cutthroat trout in Thompson Lakes in Montana was investigated in summers of 1952 and 1953. These lakes originally contained cutthroat trout and were later planted with yellow perch. Spawning time of yellow perch was in early May, of cutthroat trout in late May. The population of yellow perch was large, and growth was very slow. Although number of cutthroat trout was small, growth rate for this species was about average. Food of yellow perch was largely immature aquatic insects and plankton, while that of cutthroat trout was mostly mature aquatic insects and small perch. Yellow perch were commonly distributed along lake margins, and concentrations of perch fry and adults were found in these areas in spring. During this period the salmonid fishes were predominantly in deep water. Spot poisoning of yellow perch concentrations practically destroyed all fish in the treated area. Management suggestions are given.

ELLIS, MAX.

1914. Fish of Colorado. Univ. Colo. Studies, 11 (1): 1–136.

General discussion of trouts in Colorado; specific treatments of distributions and appearances of *Salmo c. spilurus*, *S. c. pleuriticus*, *S. c. stomias*, and *S. c. macdonaldi*.

EVERMANN, BARTON W.
1893. A reconnaissance of the streams and lakes of western Montana and northwestern Wyoming. Bull. U. S. Fish Comm., 11: 3–60.

Deals with natural-history features of trout streams and distribution of fishes, as well as requirements for fish-cultural stations. Distributional and descriptive notes on *S. mykiss* are given.

EVERMANN, BARTON W., and E. L. GOLDSBOROUGH.
1907. The fishes of Alaska. Bull. U. S. Bur. Fish., 26: 219–360.

Discussion of distribution of cutthroat trout in Alaska, description of the fish and comparison with rainbow, and fishing methods. Excellent colored plate.

FISH, FREDERIC F.
1934. Ulcer disease of trout. Trans. Amer. Fish. Soc., 64: 252–258.

Lesions of a type like furunculosis were noted on fingerling cutthroat, brook, rainbow, and lake trout and were caused by *Proteus hydrophilus*. Gross and microscopic pathology are described, and control is discussed. Photographs of lesions on cutthroat.

FLEENER, G. G.
1952. Life history of the cutthroat trout, *Salmo clarki* Richardson, in Logan River, Utah. Trans. Amer. Fish. Soc., 81: 235–248.

This study of cutthroat trout in Logan River, Utah, was based on 306 specimens collected during 1948 and 1949 with an alternating-current electric shocking machine. Cutthroat trout comprised 24 percent of the anglers' catch in 1948 and 31.5 percent in 1949. The greatest numbers were found in areas with a high stream gradient. An estimated minimum number of 43.6 pounds of cutthroat per acre and 565 fish per mile was obtained from a series of shocking operations in 1949. Scale analysis was employed in determining age of the fish. With a scale magnification of 50×, the body-scale (L/S) relation of cutthroat trout can be described as a curvilinear regression line, and expressed by the equation

$$L=3.411\ S^{1.2006}$$

Smallest average annual growth increment was 53 millimeters. This was based on a growing season of approximately 200 days. Growth began in latter part of March and extended to early October.

Relation between standard length and weight was expressed mathematically as

$$W=4.344\times10^{-5}L^{2.8253}$$

where W equals weight in grams and L equals standard length in millimeters. Coefficient of condition decreased as length of fish increased. Male cutthroat trout had slightly more weight per unit of length than females. Of 142 fish marked with jaw tags, 15 were recovered; 9 moved out of the 0.1-mile area where they were released. Spawning period of cutthroat trout in this area lasted from early April to middle of August, but most fish spawned before middle of July. Adult females ranged in size from 11 inches downward. Slightly more females were present in a total of 35 separate collections.

Insects were the main item in diet of Logan River cutthroat trout. Ephemeroptera, Trichoptera, and Diptera were principal aquatic orders taken, while most important terrestrial order was Coleoptera. Small numbers of fish eggs eaten indicated that survival was not affected. Only two occurrences of fish were found in the entire food habits study. Small size of cutthroat trout in this area is in part attributable to almost total absence of forage fish in upper Logan River.

FOSTER, FRED J.
1933. Life histories and environmental needs of native and introduced fish. In "Game Management Developments and Needs," Misc. Pub. No. 10, Utah State Agr. Coll., pp. 5–9.

Relations between cutthroat in Utah and introduced yellow perch are discussed. Kinds of cutthroat present in Utah, spawning conditions, characteristics of eggs and hatching habits of fry are presented. Causes of mortality are listed as nonfertilization, high water, and natural enemies. Life history of yellow perch is briefly discussed. Environmental needs of cutthroat are noted—character of water, food, and proper spawning conditions.

GEE, MERLE A.
1940. Report on the Upper Pecos River creel census, Santa Fe National Forest. Trans. Fifth N. A. Wildl. Conf., pp. 207–217.

A creel census was conducted in 1939 in the Upper Pecos River. Brown, rainbow, and Yellowstone cutthroat were the species caught. Brown trout, naturally reproduced, were the most abundant in the creel. Rainbows, stocked and naturally reproduced, were next in numbers in the creel. Cutthroat, planted and naturally reproduced, comprised only 9.18 percent of the catch. The cutthroat catch peaked in August, possibly as a result of midsummer recruitment. The 6- to 8-inch size class of cutthroat was the most important class.

1942. Success of planting legal-sized trout in the southwest. Trans. Seventh N. A. Wildl. Conf., pp. 238–245.

Plants of legal-sized rainbow and cutthroat trout were made from 1939 to 1941, and in spring, summer, fall, and winter plantings. Returns for the two species were generally comparable, with returns from 37.3 to 58.8 percent from spring and summer plantings. Best returns were from releases just before opening of fishing season and during the season. Overwintering of planted fish was poorer than with wild fish.

GILBERT, CHARLES H., and BARTON W. EVERMANN.

1894. A report upon investigations in the Columbia River Basin, with descriptions of four new species of fishes. Bull. U. S. Bur. Fish., 14:169–204.

Discusses morphology of various subspecies of cutthroat in this drainage and others.

GRASSE, JAMES E.

1949. Beaver and trout. Wyo. Wildl., 13 (11):4–13, 34.

Review of work on beaver-trout relations is given. Beaver in Wyoming are discussed, and place of cutthroat and brook trout in relation to these species is treated. Author concludes that beaver ponds are beneficial to trout in Wyoming, and that brook trout is beaver-pond trout in that state.

GREENE, WILLIAM S., JR.

1937. Colorado trout. Colo. Museum of Nat. Hist., Popular Series, No. 2. 48 pp.

Contains sections on *Trutta pleuriticus*, *T. virginalis*, *T. macdonaldi*, and *T. stomias*, with treatments on identification, distribution, and biology.

GRIFFITHS, FRANCIS P., and ELDEN D. YOEMAN.

1940. A comparative study of Oregon coastal lakes from a fish management standpoint. Proc. Sixth Pacific Sci. Congress, 3:323–333.

Oregon Game Commission studied certain coastal lakes in Oregon to compare productivity and to find a brood lake for coastal cutthroat. Geographical and climatological features of the lakes are discussed, fish faunas of 10 lakes are listed, and their limnology treated. Food of cutthroat of the lakes is composed mostly of insects. Condition factors ranged from 41.67 to 69.47. Suggestions for management of the lakes are presented.

HAIG-BROWN, RODERICK L.

1939. The western angler—an account of Pacific salmon and western trout. Derrydale Press, N. Y. 200 pp.

Good account in nontechnical language of biologies and life histories of cutthroats in British Columbia. Chapter on coastal cutthroats describes migrations in detail, and another on nonmigratory cutthroat contains a great deal of valuable material on habits.

HALL, E. RAYMOND.

1924. Pelicans versus fishes in Pyramid Lake. Condor, 27:147–160.

Importance of cutthroat trout of Pyramid Lake is discussed, and decline of commercial and sport fisheries is described. Investigation of white pelicans in relation to cutthroat was begun in 1924. Food habits of pelicans and their feeding behavior in herding trout are treated. Red suckers, lake minnows, lake chubs, carp, Sacramento perch, and catfish were taken by the pelicans, as well as cutthroat up to 8 pounds. Trout were considered accidental food items. It is concluded that white pelican is not detrimental to fishing industry, although local people believe it eats large numbers of cutthroat. Decline of trout is blamed on depletion of water, as well as on a dam, diversions, and pollution.

HALL, MAURICE C.

1930. Report on parasites of pelican and trout investigations at Yellowstone Lake, 1930. Unpublished report in Yellowstone Museum. 10 pp.

Studies on tapeworms in cutthroat and pelicans featured postmortem examination of pelicans for parasites and antihelminthic treatment of pelicans. Pelicans are freed from tapeworms with kamala. Relation between fish size and parasitism is discussed, as is relation between parasitism and reduced cutthroat egg production. Antihelminthic treatment of pelicans is recommended as control for tapeworms in Yellowstone Lake cutthroat.

HATTON, S. ROSS.

1932. The fish fauna of Utah Lake. Master's Thesis, Brigham Young University, Provo, Utah. 64 pp.

Synonymy, description, and habits of *Salmo utah* are given. Historical importance of this fish in Utah Lake is discussed. Gradual disappearance of species from Great Basin is described.

HAZZARD, A. S.

1932. Preliminary report of a biological survey of the streams and lakes of Grand Teton National Park and Jackson Lake, Wyoming. Unpublished rept. to U. S. Bur. Fish. 94 pp.

Cutthroat is treated at some length. Average size and condition factors are given for many waters. Spawning habits and distribution are described for Teton area. Average condition factor for all lakes was 1.345, for all streams 1.328.

HAZZARD, A. S., and M. J. MADSEN.

1933. Studies of the food of the cutthroat trout. Trans. Amer. Fish. Soc., 63:198–207.

Food studies of *S. lewisi* from Jackson Lake, Wyoming, Glacier Park, Montana, and other lakes and streams in Teton Park, Wyoming, were conducted over three seasons. Diet of smallest fingerlings is diversified, midges being most important item. Considerable variation in diet was seen from stream to stream and from lake to lake. Change in diet at 11½ inches was noted in Jackson Lake fish from crustacea toward fish. A variety of fish species was utilized. Large (11¾–14½ inches) cutthroat from Strawberry Reservoir, Utah, had only midge larvae and pupae in their stomachs. Stomachs of *Salmo gibbsii* from Middle Fork of Salmon River in Idaho had great numbers of snails, with fish, fish eggs, caddis, and stoneflies. Cutthroat diets are similar to those of other trouts.

HENSHALL, JAMES A.

1902. Food and game fishes of the Rocky Mountain region. Trans. Amer. Fish. Soc., 31: 74–88.

Several common names for cutthroat in Rocky Mountain region are given. Distribution and habits are discussed.

1906. A list of the fishes of Montana. Bull. Univ. of Mont., No. 34. 13 pp.

Red-throat trout is discussed with reference to distribution, color patterns, and habits.

HILDEBRAND, SAMUEL F., and IRVING L. TOWERS.

1927. Food of trout in Fish Lake, Utah. Ecology, 8 (4): 389–399.

Contents of 181 stomachs of brook, lake, rainbow, and cutthroat trout were studied with reference to physical conditions and plant and animal life of Fish Lake, Utah. *Daphnia*, amphipods, insects, and *Nostoc* colonies were chief organisms found. Lesser numbers of fish eggs, *Pisidium*, snails, and certain higher plants were found.

HUEY, WILLIAM S.

1956. New Mexico beaver management. N. Mex. Dept. of Game and Fish, Bull. No. 4. 49 pp.

During summer of 1955, studies were conducted to determine beaver-trout relations. Two inventories were made in each of six experimental sections of upper Red River in Taos County. Three of these contained beaver ponds and three did not. Each section had 50 yards of stream. Cutthroat, brook, and rainbow trout and white suckers were in the experimental area. Average trout population in beaver sections was 154 in June and 180 in August, as opposed to 33 in June and 47 in August for nonbeaver sections. Trout from beaver ponds were slightly larger than those from nonbeaver sections. Food production was significantly higher in beaver sections and trout growth appeared to be faster in these sections.

HUEY, WILLIAM S., and WILLIAM H. WOLFRUM.

1956. Beaver-trout relations in New Mexico. Prog. Fish-Cult., 18 (2): 70–74.

Effect of beaver activity on trout production in Red River, New Mexico, was studied. Cutthroat, rainbow, and brook trout were present: cutthroat and brook amounted to 98–99 percent of the trout.

Production was increased in beaver ponds. Ponds produced more trout than undisturbed stream areas, and growth was faster. Cutthroat were apparently not prevented from spawning because of beaver activity.

IDYLL, CLARENCE.

1942. Food of rainbow, cutthroat, and brown trout in the Cowichan River System, B. C. Jour. Fish. Res. Bd. Can., 5 (5): 448–458.

Stomach contents of 293 rainbow, 160 cutthroat, and 113 brown trout were examined and analyzed according to species, size groups (5 cm.), and habitat (river or lake). For rainbows of both river and lake (4 to 50 cm. in length), insects, chiefly Trichoptera and Simuliidae, were predominant in all size groups. Fish constituted a small fraction of the food except in winter when salmon eggs were available. River cutthroat subsisted chiefly on insects (Trichoptera) up to 15 cm., on insects and fish (*Gasterosteus*) up to 30 cm., thereafter largely on fish. Lake cutthroat did not eat fish in any number until 41 cm. long. Brown trout ate chiefly insects (Trichoptera) up to 45.5 cm., thereafter turning more definitely to a fish (salmonid) diet. Cutthroat were more piscivorous than brown trout. Definite selection of food by the trout was indicated.

IRVING, ROBERT B.

1953. Ecology of the cutthroat trout, *Salmo clarkii* Richardson, in Henrys Lake, Idaho. Master's Thesis, Utah State Agr. Coll., 101 pp.

Cutthroat trout of several stocks live in Henrys Lake with rainbow and brook trouts, whitefish, bullhead, and silverside minnow. Limnological data suggest high productivity. Growth is rapid, and body-scale relation is 21.59 mm. $+6.879\ S_i + 0.03874\ S_i^2$. Only 2 percent of cutthroat reach 5 years of age; 2 percent of rainbow and cutthroat hybrids reach 7 years of age. Length-weight relation of cutthroat is Log $W = -4.6353 + 2.9529$ Log L. Average female cutthroat has 2,703 eggs. Average total length of spawners is 18.5 inches for male and 19 inches for female. Sex ratio in 1951 was 96 males to 100 females.

Potential harvest is estimated at 89.2 pounds per surface acre. In 1951 the lake yielded 5.1 pounds per surface acre. Cutthroat in the creel averaged 2.5 pounds.

1956. Ecology of the cutthroat trout in Henrys Lake, Idaho. Trans. Amer. Fish. Soc., 84: 275–296.

Henrys Lake in eastern Idaho is a shallow, fertile lake, with an estimated 606 pounds of bottom and plant-inhabiting fauna in 1951. *Salmo clarki*, *Cottus bairdi semiscaber*, and *Prosopium williamsoni* are the native fish; *Salmo gairdneri*, *Salvelinus fontinalis*, and *Richardsonius balteatus hydrophlox* are introduced species. Rainbow-cutthroat hybrids were rare in the catch. Body-scale relation in cutthroat was $L = 21.59 + 6.879\ R + 0.03874\ R^2$. Male cutthroat in 1951 matured at ages II and III, females at ages III and IV. Severe mortality subsequent to spawning is reported for 1951. Variation in growth is attributed to differences between time spent in streams and in the lake, seasonal variation of environmental conditions, and different ages at maturity. Rates of female to male cutthroat in catch decreased with age and progress of season. Ninety percent by number and 74 percent by volume of food were midges, shrimp, and damselflies. Pathogenic bacteria infected mature fish in 1950, 1951, and 1952 spawning migrations. Asphyxiation was cause of mortalities at mouths of streams in January 1952. The population is short-lived owing to disease, asphyxiation, predation, angling, and spawning mortality.

JORDAN, DAVID STARR.

1890. The fishes of the Yellowstone Park. Zoe, 1 (2): 38–40.

Discussion of native fishes of Yellowstone Park. Describes historical geology of area and suggests that *Salmo mykiss* entered Yellowstone Lake and River from Pacific Creek in Snake River drainage.

1891a. Report of explorations in Colorado and Utah during the summer of 1889, with an account of the fishes found in each of the river basins examined. Bull. U. S. Fish Comm., 9: 1–40.

Discussions of distribution, appearance, and biology of *S. m. macdonaldi*, yellow-finned trout; *S. m. stomias*, green-backed trout; *S. m. clarki*, cutthroat trout; *S. m. pleuriticus*, Colorado River trout; *S. m. spilurus*, trout of the Rio Grande; *S. m. virginalis*, trout of Utah Lake; *S. m. bouvieri*, Waha Lake trout; *S. m. henshawi*, Lake Tahoe trout; *S. m. lewisi*, trout of the Upper Missouri.

1891b. A reconnaissance of the streams and lakes of the Yellowstone National Park, Wyoming, in the interest of the United States Fish Commission. Bull. U. S. Fish Comm., 9: 41–63.

Discusses distribution of each drainage. Much detail is given on distribution of *S. mykiss* and infestation by *Dibothrium* worms. Classified list of waters suitable for *S. mykiss* is presented.

1907. The trout and salmon of the Pacific Coast. State Bd. Fish Comm. of Calif., Rept. (1905–1906): 77–92.

Describes discovery of cutthroat in Oregon by Clark. Movements of trout species in northern hemisphere are described; movement of cutthroat from Alaska southward is traced. Color patterns are given. Tahoe trout and Crescent trout are treated separately.

1920. The trout of the Rio Grande. Copeia, No. 85, pp. 72–73.

Nomenclature of cutthroat is discussed. *Salmo virginalis* is the Rio Grande trout, and *S. utah* is the Bonneville Basin trout.

1928. The distribution of fresh-water fishes. Annual Report of Smithsonian Institution for 1927, pp. 355–385.

Principles of zoogeography are discussed, including methods of distribution of fishes. Geographic barriers throughout world are described, with their influence on groups of fishes. Dispersal of fresh-water fishes is discussed in general terms, and movement of cutthroat over Two-Ocean Pass in Wyoming is treated in detail. Speciation in cutthroat in Great Basin is described.

JORDAN, DAVID STARR, and BARTON W. EVERMANN.

1902, 1934. American food and game fishes. Country Life Press, Garden City, N. Y., pp. 175–179.

Keys to species of cutthroat are given. Discussion of distribution, biology, and habits of *S. clarki*, *S. lewisi*, *S. gibbsii*, *S. henshawi*, *S. tahoensis*, *S. utah*, *S. jordani*, *S. bathoecetor*, *S. declivifrons*, *S. virginalis*, *S. pleuriticus*, *S. bouvieri*, *S. stomias*, and *S. macdonaldi* is presented.

JORDAN, DAVID STARR, and H. W. HENSHAW.

1879. Report upon the fishes collected during the years 1875, 1876, and 1877, in California and Nevada. Report of the Chief of Engineers, Part 3, Appendix NN, Appendix K, pp. 1609–1622. Executive Documents, 3d Sess., 45th Cong., 1878–79, vol. 5.

Contains detailed descriptions of *S. tsuppitch* Richardson (black trout), *S. henshawi* Gill & Jordan (silver trout) and *S. pleuriticus* Cope (Rio Grande trout), with notes on distributions and biologies.

JUDAY, CHAUNCEY.

1907a. Notes on Lake Tahoe, its trout and trout-fishing. Bull. U. S. Bur. Fish., 26: 133–146.

Description of Lake Tahoe, its vegetation, and its plankton is given. Account of *Salmo henshawi* (Lake Tahoe trout, Truckee trout, pogy, and snipe) and *Salmo tahoensis* (silver trout) is presented. Gives distribution, breeding habits, hatchery operation, food habits, angling methods, shipments of trout from the lake, and their commercial value ($6,819 in 1906).

1907b. A study of Twin Lakes, Colorado, with especial consideration of the food of the trouts. Bull. U. S. Bur. Fish., 26: 147–178.

Describes physical characteristics of the lakes, aquatic vegetation, plankton, and fishes, including *Salmo macdonaldi* (yellow-fin trout) and *Salmo stomias* (green-back trout). Importance of study of fish food is discussed, and details of analyses of fish stomachs are given. *S. stomias* stomachs contained fish remains, insects, crustaceans, and vegetable fragments. Importance of plankton crustacea as fish food is discussed at length.

KEMMERER, GEORGE, J. F. BOVARD, and W. R. BOORMAN.

1924. Northwestern lakes of the United States; biological and chemical studies with reference to possibilities in production of fish. Bull. U. S. Bur. Fish., 49: 51–140.

Physical and biological surveys were made in many northwestern lakes for comparisons with each other and with Wisconsin lakes, and to determine suitability for trout. Cutthroat trout found in Bear Lake, Idaho, Henry Lake, Idaho, Coeur d'Alene Lake, Idaho, Hayden Lake, Idaho, Payette Lake, Idaho, Pend Orielle Lake, Idaho, Priest Lake, Idaho, and Spirit Lake, Idaho. Food habits are discussed.

KENDALL, W. C.

1915. The fishes of the Yellowstone National Park. Rept. U. S. Comm. Fish for 1914, App. VIII, pp. 1–28.

Fishing for cutthroat and other species is described for major waters of Yellowstone Park. Tapeworm parasite of cutthroat of Yellowstone is discussed. Detailed distribution of cutthroat is given for Yellowstone Park. Distribution from hatchery is listed.

LAAKSO, MARTIN.

1955. Variability in scales of cutthroat trout in mountain lakes. Proc. Utah Acad. Sci., Arts, and Lett., 32: 81–87.

Some cutthroat trout in mountain lakes fail to establish a year mark during first year of life and have scales designated as "retarded." Fry which are more advanced in their first fall have year marks corresponding to each year of life and are called "normal." Frequency of normal scales was found to be closely correlated (r.=.79) with growth index (quotient of mean length divided by mean age for each sample) in total of 12 areas.

1956. Body-scale regressions in juvenile cutthroat from Yellowstone Lake. Proc. Utah Acad. Sci., Arts, and Lett., 33: 107–111.

The body-scale regressions of juvenile cutthroat trout from different areas in Yellowstone Lake showed significant differences in slope. Curves plotted for fingerlings captured near the outlet of Yellowstone Lake exhibited steeper slopes, showing that scale growth was relatively faster than in fish collected along the lakeshore and in two small tributaries.

LAAKSO, MARTIN, and OLIVER B. COPE.

1956. Age determination in the Yellowstone cutthroat trout by the scale method. Jour. Wildl. Mgt., 20 (2): 138–153.

Fishery studies on cutthroat trout in Yellowstone Lake have required investigation into technique of age determination. Scales exhibit growth characteristics different from those of same species in other waters at lower altitudes. Present studies have centered around identification of scales on which first annulus failed to form.

Cutthroat trout in Yellowstone Lake ascend spawning streams from May to late July. Fry emerge from late June to early September. Scale formation is initiated when fish are 41 to 44 millimeters in length. Late-hatched fry may not attain this length before interruption of growth in October, and thus may overwinter without scales or with only a few small scales. As a result, three developmental types of fry occur in the population: (1) fry overwintering in a fully scaled state; (2) fry passing the winter partially scaled; and (3) fry overwintering without scales.

Annulus development after first growing season occurred on scales of fingerlings whose scale growth had reached 4-circulus stage. Late-hatched fry with rudimentary scales failed to establish a year mark during their first fall and winter period. These fish with "retarded" scales exhibit annulus formation following their second growing season. Term "retarded scale" is proposed to designate a scale that does not exhibit an annulus after first growing season, and "normal" is applied to a scale which did establish a year mark after 1 season's growth. Structural criteria have been established for identification of the two types of scale development. Bases for differentiating the types are (1) numbers of circuli before first annulus, (2) size of focus, or first circulus, and (3) shape and density of first one or two circuli.

Annulus formation begins before May 1 and is usually complete by middle of June. Spawners appear to initiate scale growth before nonspawners.

Fingerlings taken late in season and presumed to be in first year of life included 35 percent fully scaled individuals, unscaled comprised 22 percent, partially scaled made up 42.7 percent. Adults sampled from 1951, 1952, and 1953 fisheries averaged 40 percent normal.

LAND, S. E.

1913. The black-spotted mountain trout. Trans. Amer. Fish. Soc., 42: 183–198.

Salmo stomias Cope and *Salmo spilurus* Cope are discussed as to distribution and handling.

LEACH, GLEN C.

1923. Artificial propagation of brook trout and rainbow trout, with notes on three other species. Rept. U. S. Comm. Fish. for 1923, App. VI, pp. 1–74.

Describes places where cutthroat trout have been cultured. Spawning season, growth, and egg production are noted. Quotes articles relating to biology of this species. Tapeworm parasite at Yellowstone is discussed.

LINTON, EDWIN.

1891a. On two species of larval dibothria from the Yellowstone National Park. Bull. U. S. Fish Comm., 9: 65–79.

A collection of *Salmo mykiss* and suckers from Yellowstone Park were examined for parasites. Larval cestodes were found in both fishes. Detailed descriptions of anatomies of the tapeworms are given, and figures are presented. *Dibothrium cordiceps* Leidy is the worm found in the cutthroat.

1891b. A contribution to the life history of *Dibothrium cordiceps* Leidy, a parasite infesting the trout of Yellowstone Lake. Bull. U. S. Fish Comm., 9: 337–358.

Discussions of larval and adult stages of *D. cordiceps* from *Salmo mykiss* in various waters of the Yellowstone, and an account of distribution and anatomy and of pelican hosts. Author accounts for abundance of parasitized trout in Yellowstone Lake and migration of parasite into muscular tissue of its host.

1893. On fish entozoa from Yellowstone National Park. Rept. U. S. Comm. Fish. 17: pp. 545–564.

This paper treats all internal parasites found in a collection of trout, suckers, and chubs from Yellowstone Park. Parasites from *Salmo mykiss* were: tapeworm *Dibothrium cordiceps* Leidy, fluke *Distomum laureatum* Zeder, acanthocephalan *Echinorhynchus globosus* Rud. and nematode *Dacnitis globosa* Dujardin. Details of life history and biology are given for some of these parasites.

LOCKE, S. B.
1929. Whitefish, grayling, trout, and salmon of the intermountain region. Rept. U. S. Comm. Fish. for 1929, App. V, pp. 173–190.

Identification and description of salmonids in intermountain region are treated. Cutthroat is discussed in the various forms reported for drainages in this region.

LORD, RUSSELL F.
1930. Rearing a brood stock of blackspotted trout. Trans. Amer. Fish. Soc., 60: 164–166.

Sources of blackspotted trout eggs are suffering a decline in abundance, and it seems necessary to rear new brood stocks of this species. Attempts in 1920–22 at Springville, Utah, were unsatisfactory. Experiments at Pittsford, Vermont, beginning in 1926, resulted in an egg take of 115,000 eggs in 1930. An 8.6-percent loss was suffered up to the eyed stage. Shipments were made and fry were feeding nicely at latest report.

MCCONNELL, WILLIAM J., WILLIAM J. CLARK, and WILLIAM F. SIGLER.
1957. Bear Lake, its fish and fishing. Utah Dept. Fish and Game, Idaho Dept. of Fish and Game, Wildl. Mgmt. Dept., Utah State Agr. Coll. 76 pp.

The cutthroat is one of three important game fish of Bear Lake. Methods of catching cutthroat are discussed, as well as importance of cutthroat in the fishery. Gill-netting showed cutthroat to be most abundant between shore and 75-foot contour throughout year. Life history of cutthroat in Bear Lake is treated, and calculated total lengths to seventh year are given. Creel census showed that 900 to 1,000 cutthroat were caught annually from 1953 to 1956. History of planting cutthroat in Bear Lake is given. Length frequencies of cutthroat taken in creel are figured. It is concluded that present cutthroat population is only slightly exploited, and that if population density were increased, shore fishermen would probably not enjoy greatly increased success.

MADSEN, DAVID H.
1936. Protection of native fishes in the National Parks. Trans. Amer. Fish Soc., 66: 395–397.

Planting policies in National Parks are discussed, and rainbow-cutthroat hybridization through planting is described. Importance of this trend in Rocky Mountains is stressed. Policy for management of cutthroat and other native species in National Parks is presented.

MADSEN, M. J.
1940. Report on age and growth of the cutthroat trout (*Salmo lewisi*) of Yellowstone Lake, Wyoming. Unpublished rept. U. S. Fish and Wildl. Serv. 12 pp.

Studies on scales collected from Yellowstone Lake in 1938 and 1939 showed age group III to dominate the fishery, followed by age groups IV, II, and V. Sexes in catch were 54.8 percent males and 45.2 percent females in 1938; in 1939, percentages were 67.4 and 32.6, respectively.

Condition factors were calculated as 1.2271 for 1938 and 1.3027 for 1939. Condition factors for males were higher than for females.

Weight-length relations are presented.

Observations on parasitism by tapeworms were made, showing that in 1938, 31.8 percent of the fish examined were parasitized: in 1939 the percentage was 45.7. Parasitized fish had lower condition factors than did nonparasitized ones.

MERRIMAN, DANIEL.
1935. The effect of temperature on the development of the eggs and larvae of the cutthroat trout (*Salmo clarkii clarkii* Richardson). Jour. Exp. Biol., 12 (4): 297–305.

Eggs of coastal cutthroat were raised from fertilization through hatching at constant temperatures of 11.3°, 8.25°, and 6.35° C. Temperature is not limiting factor in determining length of hatching period. Average size of cutthroat embryos at hatching was smaller at higher temperatures and larger at lower temperatures. Maximum increment of growth occurred about 41st day at 8.25° C. and about 28th day at 11.3°. Percentage of dry weight of cutthroat embryos showed a steady decrease from about 25 to 14 percent, while that of yolks showed an increase from about 46 to 55 percent. Embryos absorbed water from the yolk, and at a faster rate from the environment, both before and after hatching.

MILLER, RICHARD B.
1952. Survival of hatchery-reared cutthroat trout in an Alberta stream. Trans. Amer. Fish. Soc., 81: 35–42.

Gorge Creek, typical small mountain trout stream in southwestern Alberta, was divided by fish-tight screens into two sections, each about three-quarters of a mile in length. The number of native trout in these was determined by marking and recapture. One section was left as a control. Into the other, 199 3-year-old and 201 2-year-old hatchery-reared cutthroat trout were liberated. Each of the planted trout was weighed and given a numbered Petersen tag before planting. Fish that died were removed daily and weighed. Daily angling was carried on to recapture, weigh, and again release as many as possible. One-third of the 3-year-old fish died, mainly in the first 2 weeks following planting. All lost weight for 40 days, apparently through inability to compete with the native population. By fall (about 100 days after planting) the survivors had regained their planted weights. All, or nearly all, of the 2-year-old fish died, apparently from a combination of shock and starvation. Native trout in experimental section gained weight all summer, and by fall were in as good condition as native trout in control section.

Plans for planting hatchery-reared trout in sections of stream free of native trout and for transplanting native trout into sections containing native trout are described.

1954a. Movements of cutthroat trout after different periods of retention upstream and downstream from their homes. Jour. Fish. Res. Bd. Can., 11 (5) : 550–558.

A homing experiment of cutthroat trout (*Salmo clarki*) was carried out in Gorge Creek, a small trout stream more or less typical of streams of eastern slopes of Rocky Mountains in Alberta. A half-mile portion of the stream was screeened off and, into the enclosure thus formed, 105 trout were transferred from above and 104 from below. Each of these was given a numbered tag and the home locality was recorded. Transfers were made from June 24 to August 13. On August 15 the screens were removed; September 3 to 5, most of the experimental area was poisoned with Fish Tox and the localities of tagged fish recorded. It was found that most of the trout that had been confined for 30 or more days remained in the enclosure area, i. e., they had adjusted to new homes. Exceptions appear to be result of random movements. Trout of upstream origin, confined for less than 30 days, move toward their original home territory. Trout of downstream origin, confined for less than 30 days, show very much less ability to move toward or to find their homes. Hypothesis is that trout are guided by smell in finding home.

A few observations on size of home territory suggest that it is small, perhaps not more than 20 yards of stream. Trout may inhabit same area of stream for at least 3 years.

1954b. Comparative survival of wild and hatchery-reared cutthroat trout in a stream. Trans. Amer. Fish. Soc., 83 : 120–130.

Gorge Creek, typical small mountain trout stream on eastern slope of Rocky Mountains, was used in test to measure survival and weight changes in hatchery-reared cutthroat trout (*Salmo clarki*). Resident population of this species exists in the stream. Experimental procedure was to introduce groups of trout into enclosures one-half to three-fourths of a mile long; each trout in a group was given a numbered Petersen tag and weighed before planting. Recapture by angling and reweighing was carried out throughout the season of planting and also in later summers. In this way six lots of pond-reared, one lot of stream-reared, and one lot of transplanted wild cutthroat trout were studied. Pond-reared fish exhibited very low survivals over first (0 to 4.9 percent) and second (0 to 3.1 percent) winter. Survival was largely independent of age. Transplanted, wild trout showed survivals of 46.0 to 29.0 percent to second and third summers, respectively. Stream-reared hatchery fish gave an intermediate value (17.2 percent to second summer).

All lots of trout lost weight for some 30 to 40 days when superimposed on a resident population. This loss was more severe and was regained more slowly in pond-reared trout than in transplanted wild trout.

It is held that low survivability of hatchery fish is due to absence of natural selection at early stages in life history.

1955. Trout management research in Alberta. Trans. Twentieth N. A. Wildl. Conf., pp. 242–252.

Experiments were conducted in Gorge Creek in South Saskatchewan River system to learn what happened to hatchery-reared cutthroat trout released in the stream.

With pond-reared cutthroat planted in an area with wild trout, there was an early, heavy mortality, followed by a period in which survivors lost weight. With wild cutthroat transplanted to an area with other wild cutthroat, the wild fish had lower mortalities and less weight loss than the pond fish.

Partially stream-reared cutthroat planted in the stream with wild fish suffered greater mortality than the wild, transplanted fish, but less than the pond-raised fish.

Hatchery-reared cutthroat planted in a stream with no resident population survived well and immediately began to gain weight. All groups showed low survival over first winter.

MILLER, ROBERT RUSH.

1950. Notes on the cutthroat and rainbow trouts with the description of a new species from the Gila River, New Mexico. Ann Arbor, Michigan: Univ. Mich. Press. Occasional Papers, Mus. Zool., No. 529. 42 pp.

Salmo gilae, a new species, is described. It resembles *S. gairdnerii* in some respects and *S. clarkii* in others. Status of trouts of western North America is reviewed. Comparisons between rainbow and cutthroat series are presented and discussed. Origins of *S. clarkii* are discussed.

MILLER, ROBERT R., and J. R. ALCORN.

1946. The introduced fishes of Nevada, with a history of their introduction. Trans. Amer. Fish. Soc., 73 : 173–193.

History and distribution of *Salmo clarkii henshawi*, *S. c. lewisi*, and *S. c. utah* are described in detail for Nevada. Rainbow-cutthroat hybrids are also discussed, and stocking these species in the same water is discouraged.

MOORE, H. L., O. B. COPE, and R. E. BECKWITH.

1952. Yellowstone Lake trout creel censuses, 1950–1951. U. S. Fish and Wildl. Serv., Spec. Sci. Rept.—Fish. No. 81. 41 pp.

Two years of cutthroat trout creel census on Yellowstone Lake gave estimates of catch, effort, numbers of fishermen, and catch per hour for each unit of the fishery. Variances were calculated for catch and effort estimates, and mathematical basis for shoreline census method is described.

Catches of 1950 and 1951 were 199,993 and 207,860 for Yellowstone Lake. Catches per hour ranged from 0.16 to 2.12, depending on the unit of the fishery.

MOTTLEY, C. McC.

1934. The origin and relations of the rainbow trout. Trans. Amer. Fish. Soc., 64: 323–327.

Rainbow and cutthroat forms of trout were evolving from a single salmonine stock in the last interglacial period after having been separated from progenitors of Pacific salmon by previous glaciation. Salmonine stocks were forced southward at last glaciation and then moved north again as ice melted. Cutthroats came into British Columbia from glacial Lake Bonneville and are found at higher elevations and farther from sea than rainbows.

MUTTKOWSKI, RICHARD A.

1925. The food of trout in Yellowstone National Park. Roosevelt Wild Life Bull., 2 (4): 471–497.

The cutthroat and its environment, water food and surface food, feeding habits, and hints to anglers are discussed.

1929. The ecology of trout streams in Yellowstone National Park. Roosevelt Wild Life Annals, 2 (2): 155–240.

Contains detailed descriptions and classification of Yellowstone trout streams, with lists of flora and fauna. A little about biology of cutthroat itself is given.

NEAVE, FERRIS.

1949. Game fish populations of the Cowichan River. Fish. Res. Bd. Can., Bull. No. 84. 32 pp.

Some habits and life history of cutthroat in this British Columbia stream are described. Cutthroat are very widely distributed in this system. They spawn in winter and spring. Immatures may remain up to 2 years in spawning streams. Cutthroat move randomly in streams in winter, aside from movements connected with reproduction. Growth rate is variable. First spawning is usually at 3 or 4 years of age. Spawning more than twice is exceptional.

NEEDHAM, PAUL R., and F. K. CRAMER.

1943. Movement of trout in Convict Creek, California. Jour. Wildl. Mgt., 7 (2): 142–148.

A 2-way fish trap was used in Convict Creek to study movements of brown, cutthroat, brook, and rainbow trout. Numbers of cutthroat trapped were small, and did not conclusively show migration patterns.

OLIVE, JOHN R.

1953. A bibliography of the limnology and fishery biology of Colorado. Mimeo. Publ., Colo. Game and Fish Dept., 34 pp.

Contains references to many reports and papers on cutthroat in Colorado.

PAUTZKE, CLARENCE F.

1938. Studies on the effect of coal washings on steelhead and cutthroat trout. Trans. Amer. Fish. Soc., 67: 232–233.

Effects of coal washings in Cedar River in Washington were measured on steelhead and cutthroat. Cutthroat, 1 to 2 inches, died in 30 minutes, while the control was unaffected. Steelhead, 6 inches long, died in 1½ hours.

PECHACEK, LOUIS S.

1950. Harvest of wild and stocked fish from the Logan River drainage. Master's Thesis, Utah State Agr. Coll. 103 pp.

In this study of harvest of cutthroat, brook, brown, and rainbow trouts and mountain whitefish in Logan River in 1949, it was determined that cutthroat comprised 31.5 percent of the catch, rainbows 34 percent (25.5 percent were marked rainbows).

PLATTS, WILLIAM S.

1957. The cutthroat trout. Utah Fish and Game Magazine. 13 (10): 4, 10.

This account of the cutthroat in Utah describes history and range of Utah cutthroat and Colorado cutthroat. Management of cutthroat in Utah is discussed in relation to environmental changes. Habitat, life history, spawning habits, and development of immature cutthroat are treated. Future for this fish in Utah is felt to be poor.

PURKETT, CHARLES A., JR.

1951. Growth rate of trout in relation to elevation and temperature. Trans. Amer. Fish. Soc., 80: 251–259.

A study of 758 trout from West Gallatin River indicated that growth was greater at lower elevations where water was warmer. Rainbow trout from upper and lower sections of West Gallatin River showed following differences in length at end of each year: 0.3 inch first year, 1.3 inches second year, 2.1 inches third year, 2.5 inches fourth year, and 4.0 inches fifth year. Growth rates of cutthroat and hybrid trout showed similar trend. Average summer difference in water temperature (early morning), between upper and lower stations of West Gallatin River, was 9.6° F. Condition factors did not show significant variations between sections.

Total of 184 trout from Bridger-Spring Creek did not show significant differences in growth rate. Water temperatures in stream did not vary greatly.

RASMUSSEN, DELBERT H.

1956. A creel census and fisherman expenditure study on Snake River, Wyoming. Wyo. Game and Fish Comm., Fish. Tech. Rept. No. 4. 26 pp.

A 40-mile section of Snake River was censused in 1955. Snake River cutthroat comprised 92 percent of catch and average 11 inches in length. Length frequencies and length-weight relations are given. Catch

per hour for bank fishermen was 0.74, for boat fishermen 0.64.

RASMUSSEN, D. I.

1941. Beaver-trout relationship in the Rocky Mountain region. Trans. Fifth N. A. Wildl. Conf., pp. 256–263.

Area in Wasatch National Forest containing 620 miles of stream inhabited by cutthroat, almost 200 miles of which was stocked with beavers, was studied to learn effects beavers had on cutthroat. Physical and chemical measurements and bottom fauna counts suggested that beaver did not produce adverse effects on trout. Beaver dams obstructed trout movement to some extent.

RICH, WILLIS H.

1924. Destruction of trout by pelicans in Yellowstone National Park. Rept. U. S. Comm. Fish. for 1923, App. VII, pp. 1–27.

In 1922, U. S. Bureau of Fisheries began investigation of pelicans in Yellowstone National Park, with Dr. H. B. Ward doing the work. He found that breeding period of white pelican in the park is synchronized with that of cutthroat trout. The pelican colony was 500–600 adults, and produced 200 young. Each pelican ate about 350 fish in the season. Control of pelicans by destruction of eggs was recommended.

ROBERTSON, O. H.

1947. An ecological study of two high mountain trout lakes in the Wind River Range, Wyoming. Ecology, 28 (2) : 87–112.

This study sought to explain difference in sizes of cutthroat trout from two adjacent, similar lakes. Life spans were about equal, but growth was faster in one lake. This lake had a better food supply, and its trout had food volumes in their stomachs thrice those of the smaller trout. No differences between the lakes were found in plankton counts, temperature, pH, O_2, dissolved Ca, or HCO_3. The richer lake had higher concentrations of phosphates, iodine, and organic matter.

ROUNSEFELL, GEORGE A.

1957. Fecundity of North American Salmonidae. U. S. Fish and Wildl. Serv. Fish. Bull., No. 122, vol. 57, pp. 451–468.

Measurements of egg diameters of cutthroat trout are compared with those of other salmonids. Measurements on number of eggs per female are given in relation to size of female, as well as other measures of egg size.

SCHNEIDER, PHILLIP W., and FRANCIS P. GRIFFITHS.

1943. Production of trout in a small artificial pond in western Oregon. Jour. Wildl. Mgt., 7 (2): 148–154.

Stocking of trout in Cronemiller Pond resulted in no reliable survival data on rainbows and brown trout. Later stocking of cutthroat fingerlings with wild rainbow fry resulted in survival of 71.3 percent after 14.5 months for the cutthroat. Production was 46.5 pounds per surface acre.

SCHULTZ, LEONARD P.

1934. Species of salmon and trout in the northwestern United States. Proc. Fifth Pacific Sci. Congress (Can.), 5 : 3777–3782.

Contains brief discussion and keys, in which cutthroat is included.

1936. Keys to the fishes of Washington, Oregon, and closely adjoining regions. Univ. Wash. Pub. Biology, 2 (4) : 103–228.

Contains keys to cutthroats.

1941. Fishes of Glacier National Park, Montana. U. S. Dept. Interior, Fish and Wildl. Serv., Conservation Bull. 22. 42 pp.

Has an account of distribution, keys to species, abundance, appearance, and habits of fishes of Glacier Park. Two forms of cutthroat, *S. c. lewisi* and *S. c. clarkii*, are treated. Detailed distributional tables for park waters and fishes are presented.

SIMON, JAMES R.

1935. A new species of nematode, *Bulbodacnitis scotti*, from the trout, *Salmo lewisi* (Girard). Univ. of Wyo. Pub. 2 (2) : 11–15.

Contains description of new nematode from intestine and other viscera of *Salmo lewisi* in Yellowstone Lake.

1939. 1953. Yellowstone fishes. Yellowstone Library and Museum Assoc., pp. 1–39.

Fish-cultural practices for cutthroat in Yellowstone, parasites of cutthroat in the park, and natural predators on cutthroat are discussed. Description of Yellowstone cutthroat is given with notes on habits and distribution in Yellowstone.

1946. Wyoming fishes. Wyo. Game and Fish Dept., Bull. No. 4. 129 pp.

Keys to identification of cutthroat are given, and sections on *S. clarki lewisi*, cutthroat-rainbow hybrids, *S. c. pleuriticus*, and *S. c. stomias* cover distribution in Wyoming, biology, and fishing. Illustrations of cutthroat and hybrids are included.

SMITH, HUGH M., and WILLIAM C. KENDALL.

1921. Fishes of the Yellowstone National Park. Rept. U. S. Comm. Fish. for 1921, App. III, pp. 1–30.

Cutthroat is listed as one of indigenous species in Yellowstone. Hatchery operations with cutthroat are described. Section on cutthroat gives detailed distribution within Yellowstone Park, discusses fishing, and gives something on tapeworm parasite of fish in these waters.

SMITH, OSGOOD R.

1941. The spawning habits of cutthroat and eastern brook trouts. Jour. Wildl. Mgt., 5 (4) : 461–471.

Spawning cutthroat were studied in Convict Creek, California, and observations made on distribution of

fish and spawning periods, numbers of eggs retained by females, spawning activities, night spawning, egg predation, guarding completed redd, and damage to eggs by overlapping of redds. Contains excellent photographs of spawning.

1947. Returns from natural spawning of cutthroat trout and eastern brook trout. Trans. Amer. Fish. Soc. 74: 281–296.

Experiments were conducted over three seasons to determine number of fingerlings or fry produced by natural spawning of cutthroat (*Salmo clarkii henshawi*) and eastern brook trout (*Salvelinus fontinalis*). Returns were secured by inducing wild trout to spawn in controlled and screened section of stream. Resulting fingerlings were collected by diverting water and pumping pools dry.

Cutthroat spawned in May and fingerlings were recovered in September each year.

During first summer, horizontal screens, acting as fish traps, were used below cutthroat spawning areas so that some fry were trapped soon after emerging from gravel. Other fry remained in the section and were recovered in September. Minimum survival was about 17 percent of estimated number of eggs laid. Data were obtained on fry migration and growth of fry spawned at same time.

Vertical screens were used in all other experiments so that all survivors were collected in September. Survivals of cutthroat ranged from nothing to about 6 percent of estimated number of eggs in 4 trials, each trial section containing 1 to 3 female spawning trout.

SMITH, S. B.

1955. The relation between scale diameter and body length of Kamloops trout, *Salmo gairdneri kamloops*. Jour. Fish. Res. Bd. Can. 12 (5): 742–753.

The scale-body relation for Kamloops trout is very close to direct proportion for fish larger than 4.5 cm. fork length. Observations on steelhead trout, *Salmo gairdneri gairdneri*, and on coastal cutthroat trout, *Salmo clarki clarki*, suggest that an isometric scale-body relation may exist among those species also. McMynn and Vernon have shown relation in cutthroat to be linear with a log-log regression-line slope of 1.019, compared with 1.024 for Kamloops and 1.010 for steelhead.

SNYDER, J. O.

1917. Fishes of the Lahontan system of Nevada and Northeastern California. Bull. U. S. Bur. Fish., 35: 31–86.

In this account of all fishes in this basin, *Salmo henshawi* is given a long treatment. Details of color patterns from different drainages are given, as well as counts of spots on body areas. Very detailed measurements of specimens from different waters, of both sexes, and of different size groups are shown in tables. Migrations of cutthroat are discussed. The famous large cutthroat of Pyramid Lake are described. Methods of fishing and types of gear used are discussed.

1940. The trouts of California. Calif. Fish and Game, 26 (2): 96–134.

Descriptions of morphology, distributions, and biologies and life histories of *Salmo clarki*, *Salmo henshawi*, *Salmo selenitis*, and *Salmo pleuriticus* are given in this treatment of trouts in California.

SUCKLEY, GEORGE.

1874. On the North American species of salmon and trout. Rept. U. S. Comm. Fish. for 1872–73. pp. 91–160.

This catalog of North American Salmonidae classifies the genus *Salmo*, with anadromous salmons and trouts separated from nonanadromous species. Each species is individually treated with discussion of nomenclature, morphological characteristics, colors, diagnostic features, habitat, life-history notes, and taxonomic relations. Cutthroats treated are *Salmo tsuppitch* Richardson, *Salmo clarkii* Richardson, *Salmo virginalis* Girard, *Salmo lewisi* Girard, *Salmo stellatus* Girard, *Salmo gibbsii* Suckley, and *Salmo brevicauda* Suckley.

SUMNER, FRANCIS H.

1940. The decline of the Pyramid Lake fishery. Trans. Amer. Fish. Soc., 69: 216–224.

History of Pyramid Lake (Nevada) cutthroat trout (*Salmo henshawi* Gill and Jordan) fishery, conducted by reservation Indians, shows a rapid decline in catch within last few years. While the Indian is blamed for overfishing, the white man's demand for trout, the dams and diversions that he built along the Truckee River where the trout have spawned, the pollutants that he has dumped into the river, the spawn that he has taken, the competing species of fish that he has introduced, and principally the large amounts of water that he has diverted to another watershed, have led to a condition which has prevented the trout from reproducing its kind. Revival of the fishery is made doubtful by an agreement concerning use of Truckee River's flow, expense of hatching and rearing a stock of Pyramid Lake trout (not to mention questionable availability of its eggs), and inadequate regulation of the fishery. The Pyramid Lake cutthroat trout fishery appears to be doomed.

1948. The coast cutthroat trout. Oreg. State Game Comm. Bull., 3 (12): 1, 6–8.

Study on a coastal stream, Sand Creek, was begun in 1946, with upstream-downstream traps. "Blueback" trout, (salmon-trout, harvest trout) appear in coastal streams in October in many color phases. Upstream mortality was around two-thirds. Sand Creek cutthroat spend 1 to 5 years in the stream before migrating to the ocean, most doing so at 3 years of age. In the 1946 spawning run, 19.2 percent had spawned once before, 7.0 percent twice, and 1.5 percent three times. Some may spawn without ever having gone to the ocean.

1953. Migrations of salmonids in Sand Creek, Oregon. Trans. Amer. Fish. Soc., 82: 139–150.

Upstream and downstream fish traps were maintained on Sand Creek, a small Oregon trout stream, during 4 upstream and 3 downstream fish runs (1946–49), and a smaller trap was operated on a tributary during part of 1947. Two trouts, *Salmo clarki clarki* and *Salmo gairdneri gairdneri*, and two salmons, *Oncorhynchus kisutch* and *Oncorhynchus keta*, made spawning runs in fall and winter; downstream migrations of fry and fingerlings occurred in the spring.

Water temperatures and information on occurrence and magnitude of freshets were taken. Records on fish trapped included numbers of salmonids, lengths, weights, sex ratios, loss in weight after spawning, and survival rates.

Cutthroat upstream migrants ranged from 4.0 to 10.7 inches in fork length for one size group and from 11.0 to 18.6 inches in another size group. Sex ratios of sea-run cutthroat showed predominance of females (1.00 male to 1.69 female). Weights of migrating cutthroat ranged from 0.50 to 2.94 pounds. Fork lengths of downstream migrants were from 2.7 to 10.9 inches.

Survival of cutthroat spawners averaged 32 percent. Weight loss of spawners was about one-third.

TANNER, V. M.

1936. A study of the fishes of Utah. Proc. Utah Acad. Sci., Arts, and Lett., 13: 155–184.

This treatment of fishes of Utah has keys to several forms of cutthroat, and a discussion of findings of some early explorers with regard to distribution and abundance of cutthroat in Utah waters.

TANNER, V. M., and SHELDON P. HAYES.

1933. The genus Salmo in Utah. Proc. Utah Acad. Sci., Arts, and Lett., 10: 163–164.

Two cutthroats, S. *utah* Suckley and S. *pleuriticus* Cope, are in Utah. Yellowstone and Pyramid Lake cutthroats have been introduced and have mixed with native forms. Suckley, Goode, Jordan and Evermann, and Cope are quoted with regard to cutthroats on which they worked.

TRYON, C. A. JR.

1943. The effect of covering hatchery troughs on the growth of cutthroat trout (*Salmo clarkii*). Trans. Amer. Fish. Soc., 72: 145–149.

An experiment was designed and carried out to test effect of covered troughs on growth rate of cutthroat trout at Bozeman, Montana. Analysis of data showed trout in open troughs to have significantly greater growth rate than those in covered troughs. Growth rate in open troughs was greater by 13.8 percent.

TUNISON, A. V., and C. M. MCCAY.

1933. The nutritional requirements of brook trout. Trans. Amer. Fish. Soc., 63: 167–177.

In this study on nutrition of trout a group of cutthroat trout became infested with *Octomitis salmonis*. Antiseptics were fed in liver. Control of moving forms was achieved with mercurous chloride, 0.2 percent, Hexamethylenamine, 0.5 percent, and Naphthol (beta), 0.5 percent, and partial control with carbon tetrachloride, 0.2 percent.

TURNER, C. L.

1946. A case of hermaphroditism in the cutthroat trout. Chicago Acad. Sci., Nat. Hist., Misc. No. 1, pp. 1–2.

A female cutthroat (*Salmo clarkii*) from Yellowstone Lake was examined by the author. Ovaries were normal. At the anterior end of the right ovary was a flattened oval mass, which was examined histologically. This was a small testis, with mature spermatozoa and nests of spermatogonia.

Hermaphroditism as a normal situation in other fishes is discussed.

UNITED STATES COMMISSION OF FISH AND FISHERIES.

1900. A manual of fish culture. From Rept. U. S. Comm. Fish. for 1897. 340 pp.

This manual deals with all aspects of culture of fishes raised in the United States. A small section is devoted to cutthroats.

WARD, H. B.

1923. The pelicans of Yellowstone Lake. Typewritten rept. to U. S. Bur. Fish., pp. 1–20.

Relations of the white pelican and the fish of Yellowstone Lake in 1922. Feeding habits of the pelicans were closely observed. Of the fish eaten, 98 percent were cutthroat trout. It is estimated that 350,000 cutthroat were taken by pelicans in 1922.

VERNON, E. H., and R. G. MCMYNN.

1957. Scale characteristics of yearling coastal cutthroat and steelhead trout. Jour. Fish. Res. Bd. Can., 14 (2): 203–212.

Some scale characteristics of 88 yearling coastal cutthroat trout (*Salmo clarki clarki*) and 96 yearling steelhead (*Salmo gairdneri*) were compared in some detail. Although the number of diagonal scale rows above the lateral line was significantly higher in cutthroat, counts of the two species overlap. Correlation of scale circuli counts with scale diameter was 0.94 for steelhead and 0.90 for cutthroat. At any given scale size cutthroat scales had 8 percent more circuli than steelhead scales. Measurements of lateral and longitudinal diameters and anterior radii of scales show that the anterior portions of cutthroat scales tend to be longer and narrower than those of steelhead.

Regression analyses of each scale measurement on fork length indicated that, for any given fork length, cutthroat scales are smaller than those of steelhead, the greatest difference being apparent when anterior radii are compared. Growth of scales in a dorsoven-

tral plane approximates isauxesis in relation to fork length, but scale growth in a longitudinal plane tends toward positive heterauxesis which is particularly pronounced in the anterior portions of scales.

Multiple regression analyses of scale diameter, scale row count, and fork length indicated that the smaller size of cutthroat scales is not balanced by proportionate increase in their number. When scale diameter is adjusted for scale number and fork length, cutthroat scales are 15.6 percent smaller than those of steelhead, indicating that young cutthroat are covered by their scales with less overlap.

WELSH, JAMES P.

1952. A population study of Yellowstone blackspotted trout (*Salmo clarkii lewisi* Girard). Ph. D. dissertation, Leland Stanford Jr. Univ., pp. 1–180.

A study of cutthroat populations in Arnica Creek, tributary of Yellowstone Lake, Yellowstone National Park, was made in 1950 and 1951. Sex ratio in the 1951 runs was 90 males to 102 females. Length-weight regression of Arnica Creek resident trout was calculated at Log Y=3.002 Log X—5.063. Egg counts ranged from 745 to 1,495 per female. Times of spawning runs and their variation within the season are discussed at length.

WILLOUGHBY, HARVEY.

1951. Age and growth of the cutthroat trout, *Salmo clarkii lewisi*, in Yellowstone Lake. Yellowstone Nature Notes, Yellowstone Library and Mus. Assn., 25 (3) : 29–32.

Scales were read from 523 cutthroat collected from Yellowstone Lake in 1949. Age distribution and growth rate were figured. Year class IV was best represented, followed by III, V, and VI.

WOODBURY, L. A.

1934. Parasites and diseases of the trout of Yellowstone Lake (*Salmo lewisi*). Master's Thesis, Univ. of Utah, pp. 1–60.

Treats body constants of Yellowstone cutthroat, food habits in relation to parasites, neoplasms, muscular abcess, subcutaneous abcess, gill disease, phycomycetosis, protozoan infestation, trematodes, cestodes, nematodes, acanthocephala, and copepoda.

YARROW, H. C.

1874. On the speckled trout of Utah Lake, *Salmo virginalis* Girard. Rept. U. S. Comm. Fish. for 1872–73, App. B, Ch. XII, pp. 363–368.

Life history of red-throated trout, *Salmo virginalis*, in Utah Lake, treating spawning, feeding, and movements. Maximum length was 3 feet, maximum weight 15½ pounds.

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