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A BIOLOGICAL SURVEY OF REDWOOD CREEK MUIR WOODS
NATIONAL MONUMENT, MILL VALLEY, CALIFORNIA

Date: September 30, 1954

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National Park Service

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Kenneth May

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Introduction

The material for this report was collected from a field study of Redwood Creek on the morning of September 14, 1954. The purpose of this survey was to identify the various forms of animal life occurring in the water and also to include any natural history notes of those species collected which I have in my personal files. With the permission and encouragement of Mr. William H. Gibbs, the superintendent and the assistance of Mr. Lawson H. Brainerd, park ranger the survey was completed while I was employed as a seasonal park ranger (naturalist) for the U.S. National Park Service.

Equipment and methods

The main types of collecting equipment consisted of a blue nylon dress making net material suspended between two 3 ft. hand poles and a dip net made of 3 inch cotton webbing with a handle. A hand sieve and also a small piece of wire mesh was used.

The fish were collected by holding the nylon net at an angle in the water while another person walked downstream herding the fish over the net; in this manner the net could be lifted quickly and capture the fish. This manner of fish collecting was best in water at least 6 inches deep. The dip net was used to capture the crayfish. The hand sieve and piece of wire were used for scraping in the mud for possible lamprey young.

Conclusions

The most dominant feature of Redwood Creek are the populations of silver salmon and steelhead trout. After the first rainfall in the fall of the year, silver salmon adults arrive for spawning purposes in the creek; and a few weeks later steelhead trout will arrive for spawning. We can expect to find sculpins here and a possibility of either sea lamprey or brook lamprey present, but because of the drying of this creek in certain years lampreys may be absent. No specimens of either sculpins or lamprey young were collected.

The occurrence of crayfish seems to be throughout the creek area especially in the deeper pools. Mature crayfish were collected and a few preserved.

The lack of amphibians is partly understood since most of the salamanders which occur in this region spend the spring in the creek for reproductive purposes and live most of their life on land. The yellow-legged frog was the only amphibian collected.

No attempt was made to collect the various forms of insect life of the creek but a notation would show water striders, whirligig beetles, caddis-fly cases with larvae, gnat larvae also present.

Silver Salmon Oncorhynchus kisutch Walbaum

Common Names: Silver Salmon, Coho, or Silverside

Description: Adults meristic characters gill rakers 22 (19-25), lateral line scales 151 (121-138), anal fin 14 (12-16), pyloric ceca 50-80. Adipose present; maxillary extends posterior to eye; supra-preopercle present; branchiostegals 10-20; conical teeth on jaws; teeth on vomer, palatines and tongue; scales small 14 or more from the lateral line to dorsal insertion; accessory scale present. Oblique angled anal fin. Sea-form bright silvery over sides and belly shading into dark blue on the back and head. Very little spotting along the sides above the lateral line and none in the tail. Iridescence in tail region very heavy and covering the outline of the fin rays. Tail definitely concave almost approaching an acute angle. Gum of mouth white edged in black. Spawning-form both sexes possess dark red sides with a bright red coloring in the belly region. The head and tail appear greenish and blends in with the coloring in the sides. (Steelhead have a faint red line coloring the lateral line region and the wide distribution of small black spots on the back and tail separates it from the silver salmon). Silver salmon adults are hard to hold by the tail. Young silvers Aside from the general meristic characters described for the adults the fingerlings appear to be orangish. The parr marks if present are long and narrow their width not exceeding the width of their interspaces. The first few rays of the anal fin very long, extending beyond the insertion of the last rays of the fin. The first rays of the anal fin and those of the dorsal fin edged in white.

Distribution: Monterey Bay north to the Bering Sea. Hokkaido, Japan northward into the Bering Sea. Introduced along the East Coast, South Carolina northward. Also introduced into France, England, Finland, New Zealand. Found generally between 15° isotherms, 40° latitude, and salinity 35 p.p.th..

Habitat: Not usually associated with large river systems, found in small creeks. Shaded creeks with trees along the banks providing hiding places for the fingerlings. Creek bed 6-8 ft. wide, water choked with leaves (especially tan oak) giving the water a brownish color. Pools 6 ft. wide 8-12 inches deep. Tolerate water up to 70° F. during the summer period. During the cold winter and high water seek shallows and quiet waters.

Silver Salmon Oncorhynchus kitsutch Walbaum

Reproduction: Spawning run salmon are anadromous meaning they spawn in fresh water and live part of their life in salt water. Certain streams have specific runs, like 18 months in fresh water and 18 months in salt water to complete their life cycle. In small streams the adults arrive early in the fall and wait less than a week before spawning. They spawn in the lower reaches of a stream not seeking its source. In the State of Washington at the Bonnierville Dam fish ladders silver salmon run starts around May 1st. and ends in Dec. 31st. with a peak around Sept. 1st.. In Puget Sound area the run starts around May 1st. and ends by Nov. 30th. with a peak around Oct. 1st.. The first to arrive and the most in number are the males and then the females arrive. Usually two runs in a stream, peak of early fall run small fish 4-6 lbs. and a late run in the winter about 10-14 lbs. As soon as the fall rains have filled the streams and cleared the accumulated leaves out and also opened the mouth of the stream for the adults to enter, spawning will take place.

Spawning takes place along with a falling water temperature; for Cedar River near Seattle, Wash. adults were seen spawning in water about 40° F.. The female appears bigger than the male and in cross section it is round compared to the V shape of the male's belly. In spawning, the female digs a hole with her tail in the gravel to deposit the eggs; the male spawns his milt in the water along side of the female. She deposits her eggs in groups of 200-300 eggs at a time in the depression while massaging her belly on the gravel to help extrude the eggs. Fertilization takes place in a few seconds. The spent eggs begin to absorb water as they settle in the depression dug by the female. The female moves upstream digging in the gravel to form another depression and at the same time covering the former spawned eggs with gravel. Water absorption of the eggs continue up to one hour which leaves the eggs turgid and tightly packed in the gravel. The female repeats this spawning procedure until her eggs are spent. An average female silver salmon has about 3,000 eggs. The same or another male may continue to spawn with her.

Egg development takes place 1 - 2ft. in the gravel for about 120 days depending upon the temperature and other factors. Hatching takes place in the gravel and the young fry with their yolk-sac remain there until the yolk-sac is absorbed. Then the fry work

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Silver Salmon Oncorhynchus kisutch Walbaum

Reproduction: themselves up through the gravel upon emerging begin to feed. For silver salmon that spawn in the middle of November their young will emerge from the gravel around the first of April.

Development of young proceeds through the spring and summer. In the fall the fingerlings seek the shallows especially among the roots of trees along the banks of the stream. Their first winter is spent in the stream and in the following spring with rising water temperatures they go to sea. Most of the salmon remain in the ocean throughout a year and a half but a few males may come back to the same stream the same year that they left. These fish are called "Jack salmon" by sportsmen and are usually precocious males which are infertile.

Life span The silver salmon spawns when it is 3 years old. They die shortly after spawning as is true for all salmon. The salmon dies because 1) the physiology of the kidneys can no longer function in salt water after their stay in fresh water for spawning, 2) the digestive glands have been utilized for food by the body during the spawning period and are no longer capable of resuming their normal body functions, 3) spawning colors for the eggs and body coloring are derived from the body muscle which is also utilized for food, 4) fatigue occurs after spawning activities are completed ending in death. The actual cause for death is unknown, but probably a combination factors some of which have been mentioned leads to death.

Homing instinct for the stream in which the fingerlings had left to enter the ocean isn't clearly understood. The adults return to their original stream but may by-pass the exact stream if environmental conditions in neighboring streams are similar. The adults definitely do return to the same area from which they left as fingerlings 1½ years before.

Food: Adults feed on schools of herring, sardines, and sand-lance and other small fishes, squid and an assortment of crustaceans. The fingerlings feed on all kinds of insect larvae and adults available, a few snails and some detritus.

Collection: Numerous silver salmon fingerlings were observed in Redwood Creek on Sept. 14, 1954. Our best location for netting the fingerlings was under the 2nd bridge from the main gate. All the fish collected appeared in fine condition 16 specimens were measured from the tip of the

Silver Salmon Oncorhynchus kisutch Walbaum

Collection: snout to the tip of the tail (total length). The following measurements were recorded:

4.7 cm	6.2 cm	
5.4	6.2	
5.5	6.6	
5.6	6.6	
5.8	6.7	Average length 6.0 cm
5.9	6.8	
6.2	6.9	
6.2	6.9	

Silver salmon fingerlings were observed throughout the length of Redwood Creek in Muir Woods.

Reference: Lecture notes, School of Fisheries, Univ. of Wash..
Unpublished field notes, K.W. May.

Future Studies: It would be of interest to accumulate some specific information about the silver salmon run present in Redwood Creek. Of special interest the following studies are recommended and outlined:

1. Record the first and last day that adult salmon were observed in the creek.
2. Determine if there are two distinct silver salmon runs in the creek or not by periodically counting the salmon in the water and noting their size.
3. Record carcasses of spawned salmon along the banks of the creek by length and weight measurements.
4. Determine the success or failure of spawning by cutting the female carcasses open to note percentage of eggs in the ovarian fold. Females with all the eggs intact is an indication that they were delayed in making their spawning run.
5. A few measures of fish management to encourage the continual return of salmon to Redwood Creek 1) avoid walking in water over known areas where fish have spawned in order to prevent damage to eggs and yolk-sac fry in the gravel, 2) make a trip in the fall to the creek's outlet after the first good rainfall and clear a passageway through the beach to the ocean; repeat in the spring when the fingerlings are leaving to go to sea, and 3) discourage property owners and others from poaching adult salmon from the creek and building permanent impoundments in the creek.

Steelhead Salmo gairdnerii ~~gairdnerii~~ Richardson

Common Names: Steelhead, Sea-run Rainbow, or Steelie

Description: Adults meristic characters gill rakers 7-13, lateral line scales 120-138, anal fin 9-12. Adipose present; maxillary extends posterior or to margin of eye; supra-preopercle present; branchiostegals 10-12; conical teeth on jaws; teeth on vomer and palatines; scales small 23-30 above and 20-26 below the lateral line; accessory scale present. Right angled anal fin. Tail fin posterior almost vertical. Small black spots along sides, back, and on the dorsal and tail fins. Sea-form metallic blue on dorsal surface; silvery on sides; small black spots along sides and fins are very numerous. Deep pink to red band along side of body. Spawning-form Male develops a darker red band than the female along the sides of the body. In both sexes the skin turns to a olive-green coloring. Young steelhead Aside from the general meristic characters described for the adults the fingerlings are spotted especially in the dorsal which easily separates them from silver salmon fingerlings. The parr marks if present are almost round in appearance and their width exceeds the width of their interspaces. In the water these large parr marks appear as a black line.

Distribution: Southern California north to southeastern Alaska. Lower and middle Columbia River.

Habitat: Found associated with salmon producing streams. Requirements for stream life parallels that of the salmon.

Reproduction: Spawning run steelhead are anadromous. They spend a considerable part of their life in the sea entering rivers and streams along the coast in the third, fourth or fifth years, after two or more summers in salt water, for the first spawning. They may enter fresh water in almost any month of the year although they don't spawn until the winter or spring. The size of spawning steelhead depends upon their age; the larger fish ranging from 12 to 25 lbs.. In Redwood Creek the steelhead would be the largest fish in the creek. Steelhead are noted for their jumping ability and they will be found at the upper most reaches of the creek and its smaller tributaries. Spawning takes place along with a falling water temperature. The actual process of spawning is similar to that of salmon. An average female steelhead has about 2,500 eggs. Egg development takes place in the gravel and requires 50 days to hatch the eggs at 50° F. (add 1° subtract

Steelhead Salmo gairdnerii gairdnerii Richardson

Reproduction: 5 days; subtract 1° add 5 days).
Development of young proceeds through the spring and summer. The young steelhead are closely associated with salmon in fresh water when both are present. The young go to sea after spending one or two years in fresh water. The steelhead which spend a 2nd summer in fresh water (usually fairly large streams and rivers) are called "rainbow" trout no different from the rainbow trout planted in inland waters.
Life span Steelhead spawn for the first time at 3 years old. They all probably recover from a first spawning to return to sea and later come back to fresh water to spawn for a 2nd time.
Homing instinct for steelhead is certainly not so exact as for salmon. Straying from one river to another is common and not the exception.

Food: Adults feed on herring and other fishes. The fingerlings are mainly insectivorous.

Collection: Numerous steelhead fingerlings were observed in Redwood Creek on Sept. 14, 1954. The fingerlings were found throughout the course of the creek and especially in rocky beds where they could hide among the rocks and leaves. Due to the small amount of water in the creek at this time of the year netting these fish was difficult. All of the fish collected had good coloring and a total length was recorded for 10 specimens. The following lengths were recorded:

4.1 cm	5.2 cm	
4.2	5.3	
4.9	5.4	Average length 5.1 cm
4.9	5.6	
5.0	6.7	

Several steelhead fingerlings were seen in some of the larger and more permanent pools from 2-4 inches long and were undoubtedly spending their 2nd summer in the creek.

Future Studies: It would be of interest to accumulate some specific information about the steelhead spawning in Redwood Creek. Of special interest the following studies are recommended:

1. Record the first and last day that adult steelhead were observed in the creek.
2. Record dead carcasses of steelhead by length and weight measurements. Also collect a scale sample from these fish by removing a group of scales just in front of the dorsal fin on the side of the body by scraping with a knife.

Reference: 1936 "Keys to the Fishes of Wash., Ore. and Closely Adjoining Regions". L.P. Schultz, Univ. of Wash.

Crayfish Astacus trowbridgi Stimpson

Description: First three pairs of legs chelate; cephalothorax subcylindrical; abdomen more or less flattened dorsoventrally. Margins of rostrum smooth; two spines on postorbital ridge and the second spine sometimes reduced to a tubercle; rostrum with a long acumen. Male first pleopods simply rolled at tips; pereopods of male without any basal hooks; female without first pleopods; up to 110 mm long.

Distribution: Lower Columbia River System in Oregon and Washington. Commercially caught in the Northwest and introduced in many localities in the western states.

Habitat: In shaded streams rocky and swift. On cloudy days, adults may venture into open water in the daytime. Generally found in shallow waters, seldom being found deeper than three to five feet.

Food: Omnivorous but seldom predaceous. They eat all kinds of succulent aquatic vegetation, and animal food is usually a minor part of their diet when there is abundant vegetation. Considered scavengers. The chelate appendages are used for crushing, picking up the food, and tearing it into pieces. The pieces are then passed forward where they are further cut and masticated by the maxillipeds. The maxillae strain out the larger particles and mince the smaller ones further. The mandibles are of limited use in grinding and chewing; mostly they hold food while the maxillipeds tear off fragments.

Reproduction: Time of copulation may occur between early spring and autumn. The male has no power of sex discrimination. The actual process of copulation and sperm transfer has been described for Crangonectes limosus Raf.. During the mating season the male seizes and turns over every crayfish coming his way. He mounts on her ventral side and holds all her clawed appendages securely with his two chelae. The tips of the first two pleopods are then inserted into the chink of the annulus ventralis, and the tips of the two vasa deferentia are extruded into the bases of the grooves which extend along the first pleopods. Sperm move along these grooves in macaroni-like cords and are deposited in the chink. In Astacus there is no annulus, and the spermatophores are deposited at random on the ventral surface of the female. The female lays her eggs several weeks to several months after copulation, depending on the season of the year; but before laying them she cleans the ventral surface of the abdomen thoroughly with the tips of the

Crayfish Astacus trowbridgii Stimpson

Reproduction: of the perciopods.

Egg laying takes place after the female secretes a sticky, cement-like substance (glair) from the ventral glands. The glair covers the ventral surface of the abdomen, tail fin, and pleopods. The spermatophores are released into the glair and the sperm are free. The female then lies on her back, curls the abdomen, and releases the eggs from the genital pores. By curious turning movements of the entire body, the eggs become dispersed through the glair, fertilized, and securely attached to the pleopods. The females carry the eggs between March and June. Incubation takes from two to twenty weeks.

Development of the young takes place on the abdomen of the parent until the third instar then the young leave the parent pleopods intermittently and then permanently. By autumn many females are sexually mature. Individuals hatching in the spring usually have a total of six to ten molts by autumn. Great differences in growth rate may be found within a single pond or stream, the larger specimens being twice or more as long as the smaller ones by autumn. Among the few species on which life history studies have been made, the normal life span of both male and female crayfish is usually less than 20 months, although a few survive their second winter.

Collection: There were 6 specimens of this crayfish collected on Sept. 14, 1954. The following measurements were recorded of the specimens from Redwood Creek by measuring the distance from the tip of the acumen to the end of the tail fin.

male	105 mm	Collected opposite Camp Eastwood Trail
*male	110 mm	Collected opposite redwood burl location in 1-2 ft. pool
male	99 mm	"
male	83 mm	"
*female	106 mm	"
female	106 mm	"

* killed and preserved in 10% formalin

Reference: 1953 "Fresh-Water Invertebrates of the United States"
R.P. Pennak, Roland Press New York.

Future Studies: According to Mr. Pennak there have been no recent studies made of this family Astacidae which only occurs west of the Continental Divide. Some observations at the U.S. National Museum in 1898 of the family Astacidae and a monograph of the North American Astacidae in 1870 constitutes the available literature on

Crayfish Astacus trowbridgi Stimpson

Future Studies: the subject. It would be interesting to know something about the biology of crayfish occurring in Redwood Creek. Of special interest the following studies are recommended and outlined:

1. Determine by collecting if only Astacus trowbridgi occurs here. There is a possibility of A. klamathensis, A. leniusculus or A. nigrescens occurring in this area although A. nigrescens would be the most uncommon. An artificial key and illustrations from Pennak 1953 might help in identifying these species.

1. Margins of rostrum not denticulated ----- 2

Margins of rostrum denticulated ----- 4

2. One spine on postorbital ridge; rostrum with short acumen; in lakes and mountain streams of Idaho, Wash., Ore., and Calif.

Astacus klamathensis Stimpson

Two spines on postorbital ridge; rostrum with long acumen ----- 3

3. Posterior spine of postorbital ridge long and acute; Wash., Ore., and Calif.

Astacus leniusculus Dana

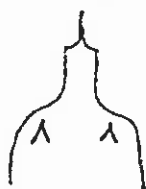
Posterior spine of postorbital ridge small, sometimes reduced to a tubercle; Lower Columbia River system Ore., and Wash.

Astacus trowbridgi Stimpson

4. Sides of rostrum nearly parallel, with five or more spines; hand of chela without a beard; Wash., Ore., and the northern half of Calif.; uncommon.

Astacus nigrescens Stimpson

Illustrations of the carapace in Astacus.



A. klamathensis



A. leniusculus



A. trowbridgi



A. nigrescens

2. Find out when A. trowbridgi was introduced into Redwood Creek and from what stock.

3. Determine when time of copulation occurs, and time when eggs first appear on the females and also time of egg hatching.

4. Continue general life history studies of behavior, feeding, distribution, and reproductive activities.

Yellow-legged Frog Rana boylli boylli Baird

Description: Eye with horizontally oval pupil; body slender, limbs long, waist narrow; no parotid gland; hind toes fully webbed; eardrum inconspicuous; throat spotted; male with bulbular swelling at base of first finger; surface of swollen area covered with minute, closely set papillae; in female first finger longer than in male and without swollen area; seldom over 3 inches; yellow underparts in life.

Distribution: Widespread in California, ranging south to San Diego County, but absent from the northeastern part, the southeastern deserts, and the most of the Central Valley.

Habitat: Frequents streams, springs, and lakes. Nearly always found within a few feet of water. Creeks with rocky courses appear to be favored. Seeks moving but usually not swiftly flowing water.

Food: Aquatic and terrestrial arthropods, particularly insects.

Reproduction: At lower elevations, as in vicinity of San Francisco Bay, this species breeds from the latter part of March to the 1st of May after the high water stage in streams is past and less sediment is being transported. Eggs deposited in clusters in streams or lakes, 3 gelatinous envelopes present. Larve metamorphose in middle of July to late August in San Francisco Bay Region.

Collection: The one specimen collected on Sept. 14, 1954 was 84 mm long with head-and-body length of 40 mm. This specimen ♀ Rana boylli boylli Baird because of the uniform colored back with numerous papillae on the skin and a long hind limb. Three frogs of this species were seen along the creek from Cathedral Grove to the Ben Johnson Trail.

Reference: 1951 "Amphibians of Western North America" R.C. Stebbins Univ. of Calif. Press, Berkeley, Calif.

Future Studies: It would be interesting to know something about the frog population of Redwood Creek. Of special interest the following studies are recommended:

1. A life history study of this species which would include its habitat, its behavior, food requirements, and reproductive cycle.
2. A representative collection of the frogs and toads which occur in the creek along with their eggs and larvae for museum display.

CHECK LIST OF AMPHIBIANS OCCURRING IN
MUIR WOODS NATIONAL MONUMENT REGION

Class Amphibia

Order Urodela NEWTS & SALAMANDERS

Family Salamandridae

- Rough-skin newt Triturus granulosus twittyi (Skilton)
Western red-bellied newt Triturus rivularis Twitty
California newt Triturus torosus torosus (Rathke)

Family Ambystomidae

- Tiger salamander Ambystoma tigrinum californicum Gray
Pacific giant salamander Dicamptodon ensatus (Eschscholtz)

Family Plethodontidae

- Eschscholtz salamander Encyrtosaurus eschscholtzii xanthontica Gray
Calif. slender salamander Batrachoseps attenuatus attenuatus (Esch.)
Black salamander Aneides flavipunctatus flavipunctatus (Str.)
Arboreal salamander Aneides lugubris lugubris (Hallowell)

Order Anura FROGS & TOADS

Family Bufonidae

- Western toad Bufo boreas halophilus Baird and Girard

Family Hylidae

- Pacific tree-toad Hyla arenicolor Baird and Girard

Family Ranidae

- Red-legged frog Rana aurora draytonii Baird and Girard
Yellow-legged frog Rana boylei boylei Baird
*Bull-frog Rana catesbeiana Shaw

* introduced into western states from the East.