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Age and Growth of the Green Sunfish Lepomis cyanellus Rafinesque in Northern Utah

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AGE AND GROWTH OF THE GREEN SUNFISH *LEPOMIS CYANELLUS* RAFINESQUE IN NORTHERN UTAH

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INTRODUCTION

The green sunfish Lepomis cyanellus Rafinesque is a member of the sunfish family Centrarchidae. Curtis (1949) states that all members of the sunfish family are native only to North America, and are primarily warm-water fish. According to Jordan and Evermann (1934) the green sunfish is generally abundant in all suitable waters from central Ohio and Indiana to the Rio Grande. Forbes and Richardson (1920) give the general distribution of the green sunfish to be from the Great Lakes to Mexico, the Mississippi Valley, and everywhere in small sluggish streams except east of the Alleghanies and in Canada. The green sunfish is not native to Utah, but has been introduced in a number of ponds in the state. It is not considered important as a pan-fish because of its limited range and small size.

However, where it does occur the fish is taken by fishermen, but not in great numbers. It could have greater importance as a pan-fish in an area where such fish are much sought after. This study was undertaken in order to understand its life history and ecology in Utah, and as a contribution to possible management of an unused food resource.

REVIEW OF LITERATURE

Various types of studies in north-central waters of the United States have contributed much to our general knowledge of the fish. A study of the age and growth of green sunfish was included in an investigation of the fish population of Deep Lake, Michigan, by Carbine and Applegate (1948). They found the maximum age to be five years, and the maximum total length to be 5.9 inches, from a sample of 184 fish. Roach (1948) found a maximum age of five years and a length of approximately seven inches in a sample of green sunfish taken in Ohio. Growth studies of the green sunfish have also been conducted by Carlander (1949), and Carlander and Sprugel (1948).

Hubbs and Cooper (1935) found "double annuli" on the scales of green sunfish included in an age and growth study in Michigan. They state that both winter and breeding growth checks are included in the annuli, and that spawning definitely registers on the scale. Growth checks similar to the "double annuli" were found on the scales of the Northern Utah green sunfish.

There apparently has been nothing published on age and growth of the green sunfish in Utah waters.

LOCATION AND HABITAT

The fish used in this study were taken from ponds located in Cache Valley which is in the northern part of Utah immediately south of the Idaho State line. The ponds are in close proximity to one another and lie at an elevation of about 4500 feet. They average between 5 and 15 feet in depth, except in the area of the springs where depths down to 55 feet have been recorded. The year round water temperature usually averages between 60 and 65 degrees Fahrenheit. The water is alkaline and turbidities rarely exceed 27 p.p.m. The bi-carbonate content is high, ranging up to 218 p.p.m., but carbonates are comparatively low. Sulfates range from 15 to 22 p.p.m. The bottoms consist of silt, muck, peat and detritus, except around the springs where sand is the main constituent.

The most commonly occurring plants in and around the ponds are hard-stem bulrush, Scirpus acutus Muhl.; three-square, S. americanus Pers.; common cattail, Typha latifolia L.; sago pondweed, Potamogeton pectinatus L.; sedge, Carex sp.; and lesser duckweed, Lemna minor L. Blanket algae, Rhizoclonium hieroglyphicum (Ag.) Kutz., is also common. Insect life appears to be abundant, and the most dominant crustacean seems to be Gammarus sp.

Other fish inhabiting the ponds with the green sunfish are northern largemouth bass, Micropterus salmoides salmoides (Lacépède); bluegill, Lepomis macrochirus Rafinesque; carp, Cyprinus carpio Linnaeus; northern black bullhead, Ameiurus melas melas Rafinesque; webug sucker, Catostomas

fecundus Cope and Yarrow; and Utah chub, *Gila atraria atraria* (Girard). Carp is the dominant species in the ponds, totaling 80 or 90 percent of the population. Black bullheads, suckers and chubs are few to rare in occurrence.

DESCRIPTION AND HABITS OF THE GREEN SUNFISH

Description

Jordan and Evermann (1934) describe the green sunfish as relatively small, with a maximum length of about eight inches and a maximum weight of about five ounces. They state that it can be readily told from all other species because the black opercular spot covers only the bony or hard part of the opercle. Hubbs and Lagler (1947) separate the green sunfish from other members of the family Centrarchidae by the short, rounded pectoral fins, opercle stiff to margin, long and slender gill-rakers, and 44 or more scales in the lateral line. Forbes and Richardson (1920) confirm that it is a small panfish, usually not weighing more than a quarter of a pound.

Food Habits

According to Eberhardt (1950) the green sunfish from ponds in northern Utah seemed to feed on insects and crustaceans more than on fish during 1949 and 1950. He states that fresh-water shrimp made up a large percentage of the diet. Roach (1948) in analyzing the stomach contents of a sample of green sunfish from Ohio waters found fish to comprise 45 percent of the diet, with insects contributing 40 percent and crustacea only 10 percent. Forbes and Richardson (1920) state

that the green sunfish in Illinois avoids mollusks and crustaceans and depends upon fishes and insects for food.

An unusual item included in the diet of a 6-3/4-inch, 20-ounce green sunfish was discovered by Huish and Hoffmeister (1947). They found a short-tailed shrew, Blarina brevicaude carolinensis (Bachman), along with other more common items of food in the stomach of the sunfish. The shrew was the only one found in 84 stomachs examined by Huish and Hoffmeister at Lake Glendale, Shawnee National Park, in Illinois.

Aggressiveness

In making a study of green sunfish in aquaria, Greenberg (1947) noted that the males establish territories and are aggressive to any fish intruding. He also contends that aggressiveness decreases with distance from the territorial center. He observed that first year fish attempt to defend territories even before they are sexually mature. They showed a full fighting pattern with gill covers spread and attacked their opponents head-on; sometimes grasping the opponents jaw.

Breeding Habits

The male green sunfish observed by Greenberg (1947) constructed an oval nest and guarded it before and after the eggs were laid. The females participated only in the process of egg-laying.

Roach (1948) states that the green sunfish in Ohio generally are mature in their second year and may spawn when two inches long. The fish studied by Hubbs and Cooper (1935) in Michigan did not reach sexual maturity until they were about three inches long.

Hybridization

Green sunfish have been known to hybridize with other species of the sunfish family. Radcliffe (1914) found fish that were evidently hybrids of the Warmouth, Chaenobryttus gulosus (Cuvier & Valenciennes), and the green sunfish. Bennett (1945) found hybrids of the bluegill and green sunfish in artificial lakes in Illinois.

METHODS AND PROCEDURE

A collection of 403 green sunfish was taken from eight ponds in northern Utah by hook and line, seining or poisoning with rotenone. The most successful method was poisoning with rotenone. More than the usual amount had to be used for each acre-foot because of the constant inflow of fresh water from sub-surface springs. Normally on part per million is used, but in some of these ponds as much as three partz per million were used. Seining and hook and line were too slow to be practical.

The data from the sunfish taken consisted of total, fork and standard lengths in millimeters, weight in grams, sex, and the degree of sexual maturity. Scale samples were collected from the left side two rows above the lateral line and immediately anterior to the dorsal fin. Data on the general ecology of the habitat were also taken.

The plants collected from around the ponds were identified by the manuals of Fassett (1940), Muenscher (1944), and Smith (1933). The crustaceans were verified by use of the key by Ward and Whipple (1945). The fish nomenclature used in this paper is that recommended by Robert R. Miller, Associate Curator of Fishes, Museum of Zoology, University of Michigan, Ann Arbor.

The laboratory work consisted of scale measurements and interpretation in relation to growth rates as revealed by age classes. The scales were mounted on microscope slides in either a gum-arabic or

glycerin-gelatin medium, and projected on a screen by a projection microscope. A 32-millimeter lens gave the best definition at a magnification of 40X. An inch-wide oak tag strip was laid with the right edge along the anterior radius of the projected scale, and the annuli were marked on the strip with Roman numerals.

The growth for each year of life was calculated with the aid of a nomograph similar to that described by Carlander and Smith (1944). The nomograph is based on the principle that parallel lines cut proportionate sections off of divergent lines. According to Carlander and Smith a straight line nomograph is usually plotted on a 1/10-inch cross section graph paper. The numerical increases between the horizontal lines are equal.

The marked oak tag strips were placed on the straight line nomograph with the focus mark on the length intercept and the anterior margin of the scale mark on the standard length. The standard lengths at the end of each year of life were then read in millimeters at the points of tangency of the annulus mark and the horizontal line. The nomograph used in this suudy was four units to each 1/10-inch.

The oak tag strips were arranged by standard lengths into 10-millimeter groups and recorded on growth data sheets including age class; serial number; sex; scale radius (X40); standard, fork and total lengths in millimeters; weight in grams; and the coefficient of condition factor, K.

The ratio between the standard length and the anterior scale radius (X40) was determined by dividing the average anterior scale radius into the average standard length (Table 1). The body-scale relationship was determined by plotting the group averages of the standard lengths against the average scale radii for each group

(Figure 1). The data were represented by a straight line, so the least squares method was used to fit a line mathematically to the plotted data.

The increments of growth are calculated by taking the difference between the weighted averages of two consecutive years. The same fish, however, must be used in both cases. It was possible to do this for six age groups.

Some of the specimens were preserved in formalin before measurements were taken. Because shrinkage occurred a correction factor for converting preserved lengths and weights to fresh lengths and weights was applied. Since so few specimens were preserved it was felt that the correction factors computed by Carlander (1950) would be sufficiently reliable for these fish. For converting lengths of preserved fish to fresh lengths the former were multiplied by 1.012; weights of preserved fish were multiplied by 0.947 to get estimated fresh weights.

BODY-SCALE RELATIONSHIP

The scales from 389 fish were used to derive the length:scale ratio, as well as furnishing the reading of the annuli to determine standard lengths at various years of life. As revealed by Table 1, the length:Scale ratio decreased from 1.62 to 1.26 as the fish grew larger.

The body-scale relationship indicates that there is a correlation between the growth of the scale and the body length. By this method the study of scales enables the fisheries research worker to study past growth.

The length intercept is the theoretical length of the fish at the time the first scales appear. A length intercept of 12.8 and a slope of 1.17 for the regression line was computed (Figure 1). The slope here indicates that an increase of one unit on the X asix would give an increase of 1.17 on the Y axis.