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SPAWNING ECOLOGY OF THE WHITE BASS *ROCCUS CHRYSOPS* (RAFINESQUE) IN UTAH LAKE, UTAH[1]

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Utah Lake, located in Utah County, north central Utah, is one of the most important natural fishing lakes in the state. The species of prime importance to the fisheries of the lake are the Channel Catfish, *Ictalurus punctatus*, (Rafinesque) and the Walleye, *Stizostedion vitreum vitreum* (Mitchill). Of increasing importance to the sport fisheries is the White Bass, *Roccus chrysops*, (Rafinesque). This species was introduced into Utah Lake in the summer of 1956 when 209 fish were transplanted from Colorado. No subsequent plantings have been made. Since its introduction, the White Bass has shown a phenomenal increase in numbers.

This large lake lies in a north-south axis and is slightly over 20 miles long. The extreme east-west axis is slightly over six miles wide. Surface area at maximum capacity is 95,900 acres (Lawler, 1960). Average depth in June 1966 was eight feet (Figure 1). The lake is unique in that it lies in the center of an arid region (annual rainfall of approximately 15 inches) and receives water from clear

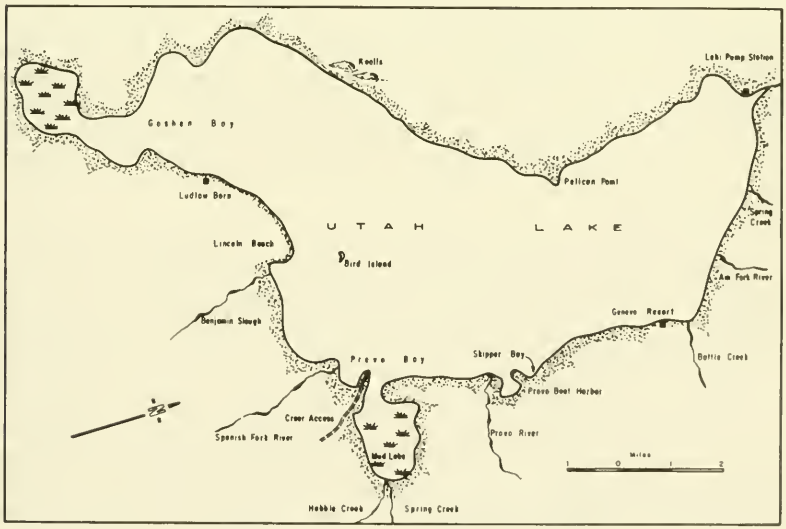

Fig. 1. Outline map of Utah Lake showing major tributaries and points of reference.

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mountain streams, yet it is always turbid. The shallowness of the lake basin and the persistent winds stirring the mud and silt of the lake into the water are responsible for the turbidness. Summer turbidity measured after normal winds during August 1959 reached a maximum of 45 ppm SiO_2 equivalents (Arnold, 1960).

Because of the irrigation demands of Salt Lake Valley, the lake is constantly fluctuating. Surface water temperatures never exceeded 72°F. during the period of this study, although Lawler (1960) reported 82°F. readings in 1959.

The study of the spawning ecology of the White Bass in Utah Lake was initiated in 1964 and completed in 1966. The principal objectives of this study were: (1) to locate the spawning grounds and (2) describe the activities of the Bass prior to, during, and after spawning.

Publications concerning various phases of life history and homing of the White Bass are numerous. Hasler and Henderson (1963), Lewis (1950), McNaught and Hasler (1961), Sigler (1947), (1949a, 1949b), and Horrall (1956 and 1961) have contributed greatly to the overall knowledge of this species. Riggs' study (1955) on the reproduction of the White Bass in Shafer Lake, Indiana, is one of the few comprehensive works regarding spawning of this species.

History

White Bass were introduced into Utah Lake in the summer of 1956 from fish obtained from the Colorado Game, Fish and Parks Department. Ten years after its introduction, the species had spread throughout Utah Lake, up into its tributaries and north along the Jordan River (including its tributaries) to Salt Lake City. The range has been extended within the state recently with a limited introduction into Delta Reservoir near Delta, and Willard Bay Reservoir near Ogden, Utah.

The natural range of the White Bass was originally Minnesota, Wisconsin, Michigan and the Great Lakes, especially Lake Erie (Hubbs and Lagler, 1947). Stocking throughout the country has extended the range of the White Bass south along the Mississippi and Ohio River drainages to the Gulf States of Alabama, Mississippi and Florida, and southwest into Texas, Oklahoma, New Mexico and Arizona. The densest populations can be found in Texas and Oklahoma, notably Lake Texoma (Sigler and Miller, 1963). Hubbs *et al.* (1947) reported that the range of the White Bass extended east through New York via the St. Lawrence River to the city of Quebec. A recent introduction into Lahontan Reservoir, Nevada, from bass taken from Utah Lake appears to have been successful. This is believed to be the most westerly successful introduction of this species. In January 1967, 150 White Bass from Utah Lake were flown to California Department of Fish and Game personnel for introduction into Nacimiento Reservoir north of Paso Robles. The success of this stocking effort has yet to be determined.

Study Area

From the beginning of this study, it was felt that the White Bass in Utah Lake would likely seek out firm bottom types for spawning. As only five percent of Utah Lake's basin has a firm bottom composition, chances were that the spawning grounds could be located in the first summer's study. However, all possibilities had to be carefully checked.

Sampling began in mid-June 1965 near the southern portion of Goshen Bay. This was somewhat later than anticipated because of equipment problems. Four gill nets, two floating types used for sampling to a depth of six feet and two divers for bottom and intermediate zone samples with identical mesh sizes, were fished at the same time but in different locations. Net specifications were as follows: 125 feet long, six feet deep with stretch mesh sizes from ¾ inch to 1¾ inches. Each net consisted of five sections, 25 feet per section.

The four gill nets were deployed so that the combined sets could cover as much area as possible. The nets were moved after a set had been pulled and reset in a new location, usually one to three miles from the previous set. There were times when all four nets were set in one area; however, the nets were usually fished in pairs in different locations.

During mid-June and July of 1965, neither the unisexual schools of females usually located near spawning grounds nor the unisexual schools of mature males found on the spawning grounds were located. Nets placed in the only major inflowing water, Provo River, failed to sample any bass during the study period, thus eliminating all areas as to possible spawning sites except the suspected hard bottom areas of Lincoln Beach and Bird Island. Of the 111 males collected in 1965, 88 or 79.3 percent were subadults[3]; and of the 49 females collected, 44 or 89.9 percent were subadults.

Numerous gill net sets were made along Lincoln Beach and off Bird Island in order to determine the range of spawning activity during the spring and summer of 1966. No spawning activity could be found off Bird Island; however, spawning activity was discovered off Lincoln Beach, which was then divided into three sampling areas of 3,000 feet in order to determine the range of utilization for spawning (Figure 2).

Sample area I consisted of the west boat basin along the south shore past the rocky out-croppings (see Figure 2). Two small warm water springs were located in this area in three feet of water. Temperatures in each spring were a constant 81° F. during the course of the study. The lake bottom bordering the adjacent section II consisted mostly of ledge rock and rubble and extends into the lake no more than 200 feet. Toward the west boundaries of section I the bottom material changes to mud and organic silt.

The lake basin sample area II is composed entirely of ledge rock and rubble. This rock formation extended out into the lake a dis-

3. A subadult is defined as a Bass too young to spawn or one that will spawn the following year.

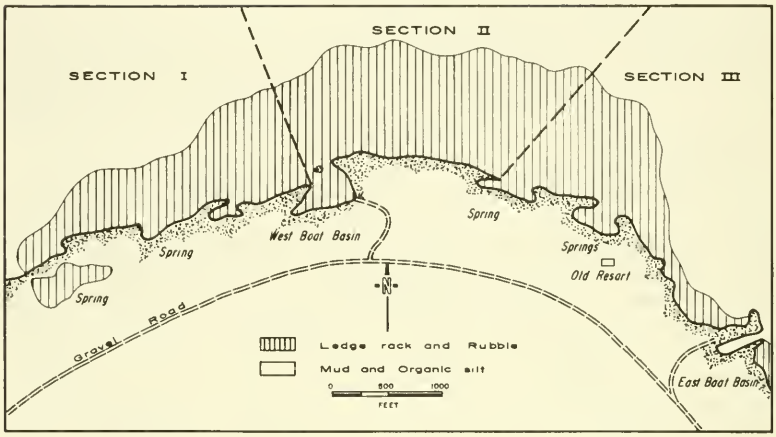

Fig. 2. Lake bottom types off Lincoln Beach, from photograph and ground observations, September 7, 1966.

tance of 750 feet. Distances from shore would markedly vary with surface fluctuations in this shallow littoral zone. The majority of spawning occurred in this area.

Section III lies to the west of the large bay into which Benjamin Slough empties. The only areas of ledge rock occurred adjacent to section II. The lake basin, 10 feet off shore and south to the east boat basin, was composed of mud and organic silt. Two large warm water springs occur in this area. Water temperatures in these springs varied from 71° to 75°F. throughout the length of the study.

Spawning Migrations

Unisexual Schooling Prior to Spawning

It is generally agreed by various workers that White Bass gather together in large unisexual schools prior to spawning. Riggs (1955) noted that unisexual schooling was first apparent in Buckey Lake, Ohio, when water temperatures reached 58°F.

In Utah Lake, signs of unisexual schooling first appeared when water temperatures reached 52°F. in mid-April. Small numbers of mature males were taken off Lincoln Beach during this period, but it was not until water temperatures reached 56°F. in late April that numerous homogenous groups of mature male bass appeared in gill net sets.

At no time during the study were large unisexual schools of mature female White Bass located in Utah Lake. Riggs (1955) and Sigler (1949a) noted that mature females were captured from deeper water, often just off shoals or tributary mouths. Extensive gill nettings in shoal areas near Lincoln Beach failed to locate these female

unisexual schools. Gravid female bass were taken in nets on the spawning grounds prior to, during, and after spawning, but never in large numbers. However, a limited number of gravid females were sampled in the large area between Creer Access and Bird Island leading the author to believe that this area is the schooling location for the gravid females prior to movement to the spawning grounds off Lincoln Beach, a distance of three miles.

It was also of interest to note that no immature bass of either sex were ever taken on the spawning site during or just prior to spawning.

The first large number of mature male bass to be captured off Lincoln Beach in net sets appeared the first week of April. Their number did not seem to increase significantly after this earlier observation, although sets made one month later produced larger males than did the earlier sets. On May 6, 1966, when water temperatures had reached 63°F., the first gravid females appeared over the spawning area. From all indications, it appears that the gravid females migrate to shoal areas in small numbers, spawn, and then return to the area off Creer Access, never remaining over the shoal longer than is necessary to spawn.

Reproduction

Spawning Site

The only spawning activities observed during the course of the study were in the area off Lincoln Beach. There was no attempt to spawn near the Bird Island shoals, although the bottom composition is identical with that off Lincoln Beach (rubble interspersed with ledge rock and boulders). There is no evidence to explain why the bass selected Lincoln Beach and not Bird Island or why they were not found utilizing both locations, as they are only separated by 1.5 miles of water.

Spawning activities around Lincoln Beach were restricted to an area beginning near the East Boat Basin and extending west to about 0.25 mile east of the boat basin near the old resort. Spawning activity extended out from shore a distance of 15 feet over the ledge rock but never beyond this bottom type into the mud (Figure 3). White Bass were taken by gill nets in stands of Tamarix, *Tamarix pentandra*, that has been inundated by high water. However, the actual spawning took place in open water, 10 to 15 feet off shore.

Eggs were taken off the ledge rock in 60 inches of water. This type of rock is quite porous and affords good holdfasts for the demersal and adhesive eggs.

Water Temperatures

The first observed spawning activity on Utah Lake occurred on May 6, 1966, when surface temperatures off Lincoln Beach were 63°F. The females continued to spawn through the middle of June when surface temperatures reached a maximum of 69°F. Males

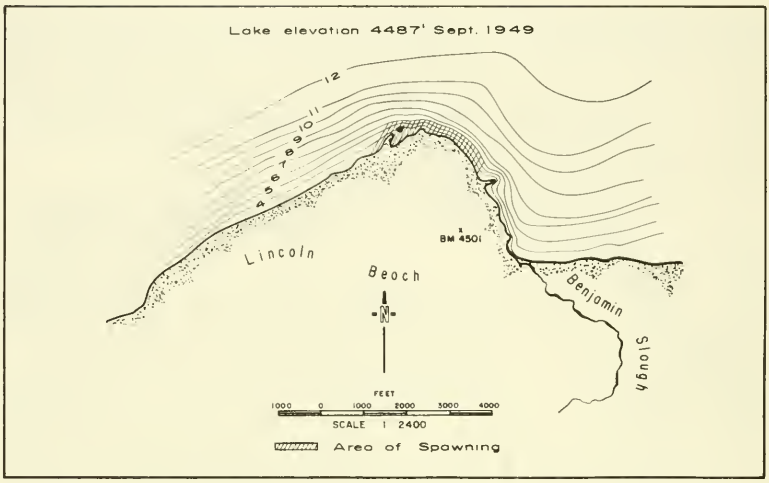

Fig. 3. Map of Lincoln Beach area, showing lake contours in feet, and principal areas of spawning (shaded).

moved over the spawning site during late March and early April when surface temperatures ranged between 48° to 52°F. Utah Lake water was found to be homothermic during the spring and early summer months.

Duration of Spawning

The first ripe, partially spawned-out female was taken in a gill net on June 10, 1966. It was shortly after this (on June 15) that spawned-out females were captured. Spawning activity lasted from 10 to 15 days on Utah Lake, although other investigations have found that the spawning periods lasts from five to ten days.

Behavior During Spawning

Owing to the extreme turbidity of the water in Utah Lake, actual spawning activities were never observed. Ripe males could be taken in nets throughout the day or night over the ledge rock, but most activity occurred in the late evening and early morning. Gravid females were never taken prior to 0400 and never after 0900 hours. Spawning bass generally come within six to eight inches of the surface; this is then followed by a confused scramble with many fish milling in wild gyrations about a central fish. Immediately after this there appears a cloudiness, apparently caused by emitted sperm. The fish then return quickly to their original locations.

By the first part of July, bisexual schools of bass could be found feeding in the Mud Bay area of the lake, indicating that the unisexual populations soon unite to form into large and fairly rapidly moving feeding schools. By Mid-August, adult females as well as males were found together throughout the lake.

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