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ENVIRONMENTAL CORRELATES OF SEASONAL ABUNDANCE AND MOVEMENT OF FISH IN ROUND LAKE, IDAHO

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ABSTRACT

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Seasonal abundance and movement of seven species of fish were investigated during 1965 in Round Lake, Idaho. A total of 47,500 fish captured in gill and trap nets was used to assess relative abundance. There were extensive movements of fish between Round Lake and contiguous Lake Coeur d'Alene. Perch reached their maximum abundance in Round Lake in May. Crappie were most abundant in June. In July, tench, pumpkinseed and squawfish were the most numerous. Bullhead and suckers were found in greatest numbers in August.

The fish fauna of Round Lake appears to be composed of seasonally-abundant populations influenced most strongly by the temperature, percent saturation of dissolved oxygen and depth of water. Most recovered tagged fish remained near the point of tagging throughout the summer. In fall, when the lake level was falling rapidly, the tagged fish recovered moved into Lake Coeur d'Alene and other contiguous bodies of water.

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Environmental Correlates of Seasonal Abundance and Movement of Fish in Round Lake, Idaho

By

Pat E. Marcuson[1] and Norman R. Howse[2]

This paper reports a study of seasonal abundance and movement of seven species of fish in Round Lake, Idaho, together with environmental conditions under which seasonal changes took place.

Round Lake, in northern Idaho, originally was a 150-acre, round body of water located on the north side of the lower St. Joe River near Lake Coeur d'Alene. There was no direct water connection between Round Lake and Lake Coeur d'Alene before 1906 (Davenport, 1921), the year when Post Falls Dam was completed at the outlet of Lake Coeur d'Alene, raising the water level. A finger or bay formed on the southernmost portion of Lake Coeur d'Alene included the original Round Lake, and is now known as Round Lake. It is 3 miles long and one-half mile wide, or about 1,080 acres during stable summer water levels, and is seasonally characterized by fluctuating water levels, high summer water temperature and a luxuriant growth of aquatic plants occupying approximately 50% of the water surface. Heavy algal blooms are also typical during the summer. The lake has a soft silt bottom and an average water depth of 2 meters. Maximum depth is 6 meters in the original lake basin.

The seven species of fish we found most commonly in the lake were yellow perch **Perca flavescens** (Mitchill), brown bullhead **Ictalurus nebulosus** (LeSueur), black crappie **Pomoxis nigromaculatus** (LeSueur), pumpkinseed **Lepomis gibbosus** (Linnaeus), tench **Tinca tinca** (Linnaeus), northern squawfish **Ptychocheilus oregonensis** (Richardson) and large scale sucker **Catostomus macrocheilus** Girard. Other species found in lesser quantities were the largemouth bass **Micropterus salmoides** (Lacepede), rainbow trout **Salmo gairdneri** Richardson, cutthroat trout **Salmo clarki** Richardson, brook trout **Salvelinus fontinalis** (Mitchill), kokanee **Oncorhynchus nerka** (Walbaum), redside shiner **Richardsonius balteatus** (Richardson) and black bullhead **Ictalurus melas** (Rafinesque).

METHODS AND MATERIALS

Six gill net stations (Fig. 1) were established in Round Lake in several habitat types and depths. Nets used were monofilament nylon. Each station was sampled each 3 weeks from April 15 to December 4,

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1965. Two trap net stations were also established. The trap nets were similar to those described by Crowe (1950).

The total number of fish of all species caught in gill nets and trap nets was used to estimate relative abundance. Both gill nets and trap nets were selective and abundance estimates derived from their use must be viewed with caution. Carlander (1942), after several years of intensive gill-net fishing in Lake of the Woods, concluded that measures of abundance based on gill net catches provided valuable information if enough samples were secured and if it was realized that the data were not measures but estimates of abundance. A total of 5,284 fish of all species caught in the trap nets was tagged with a barb or jaw tag, and most fish were released at the point of capture. About 200 fish transported from trap net sets, were released at each gill net station. Tag recoveries and observations of spawning activity provided data on movement patterns.

Limnological data were collected every three weeks at each of the six gill net stations. Physical data collected included air and water temperature, water depth, light penetration, assessed using a Secchi disk, and turbidity assessed using a B and L Spectronic 20 Colorimeter. Chemical analyses included those for dissolved oxygen, free carbon dioxide, pH, total nitrate and nitrogen, total meta- and ortho-phosphate, and total iron. Procedures of the American Public Health Association (1955) were used to assess total dissolved solids. All other chemical

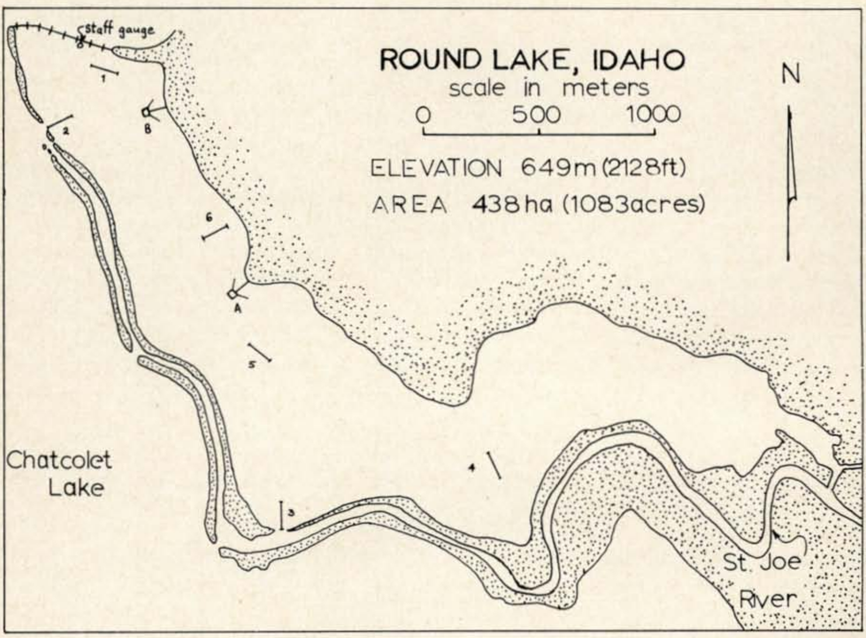

Figure 1. Location of gill nets 1 through 6 and trap nets A and B, Round Lake, Idaho.

analyses were made according to procedures outlined in Hach Procedures for Water and Sewage Analysis.[3] Biological data obtained included plankton and benthos. Plankton invertebrates were collected with a ten-liter Juday plankton trap fitted with No. 20 silk bolting cloth in the straining cone and bucket. Organisms were preserved in 95% ethyl alcohol and later measured by total volume, wet weight, and numbers of each taxonomic group. Qualitative sampling of the benthos was executed with a 231 cm^2 (6-by-6 inch) Ekman dredge. One sample per station was taken and separated from bottom soils by sieving through a No. 30 Tyler screen. Organisms were measured by total volume, wet weight, and numbers of each taxonomic group. An IBM 1620 computer program was used for partial data analysis.

A stepwise multiple regression analysis was used to measure possible correlations between abundance of the seven most common fish species taken in the gill nets and certain environmental factors. The latter included temperature, depth, dissolved oxygen, turbidity, depth of light penetration, benthic invertebrates per sq. meter and number of zooplankters per liter.

RESULTS

Limnological data. The mean water temperature in Round Lake increased from 6.5° C in April to 22.5° C in August, then decreased to 1.5° C in December (Fig. 2). By February 3, 1966 the lake had about 15 cm of ice on the surface.

In the spring of 1965, the St. Joe River overflowed its banks and the water level, measured with a staff gauge attached to a railroad trestle at the northern end of Round Lake, rose to 3.6 meters. The water level decreased after the peak flow, and during the summer months was stable at 2.6 meters. Fall drawdown began in mid-November and became maximal in early March 1966. During these winter months the lake had less than 0.5 meters of water at the staff gauge (Fig. 2).

The mean depth of light penetration increased during spring and early summer months and then sharply declined to less than 0.5 meters during mid summer due to a bloom of **Anabaena.** As the water temperatures decreased in fall, light penetration again increased and the bottom became visible over most of the lake.

The range of turbidity values in Round Lakes was 0-65 ppm SiO_2. Analysis of water chemistry data (Table 1) indicated that bicarbonate alkalinity remained stable during spring, summer and fall and carbonate alkalinity occurred only during summer. Seasonal calcium hardness values progressively increased with an over-all mean of 16 ppm. Maximum concentrations of dissolved solids occurred during summer in the original lake basin, attaining a level of 79 ppm which was primarily due to organic material (58 ppm). Dissolved solids in spring

[3] Hach Chemical Company, Ames, Iowa.

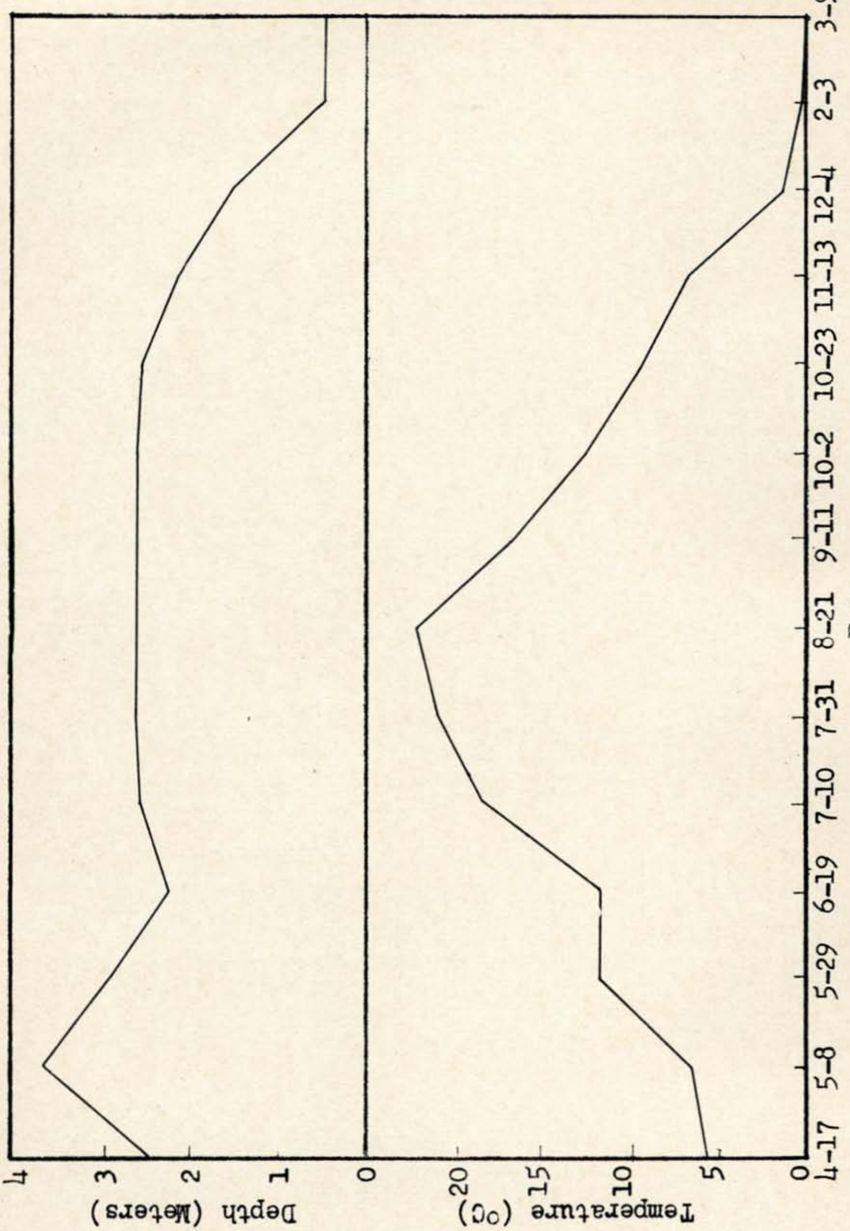

Figure 2. Mean depth in meters and water temperature °C, April 17, 1965 to March 9, 1966.

Table 1. Chemical water quality of Round Lake from April to December, 1965. (All figures in ppm except pH).

Chemical characters	Range	Mean
Alkanity		
M. O.	54-60	59
Phth.	0-20	5
Total	53-80	64
Calcium Hardness	12-20	16
Total Dis. Solids	34-79	47
Total Iron	.17-.48	.31
Free CO_2	0-17	7
pH	7.0-9.5	7.8
D. O.	0.1-15.6	8.0
Nitrogen		
Nitrite	0.0-.025	.003
Nitrate	0.0-.576	.172
Total	0.0-.600	.175
Phosphate		
Meta	.09-.27	.18
Ortho	.03-.14	.09
Total	.16-.41	.30

and fall primarily consisted of inorganic matter. Iron was present throughout the sampling period with a mean concentration of .31 ppm. Free carbon dioxide varied from summer lows of zero to a maximum of 17.0 ppm in spring. Hydrogen-ion concentration was inversely proportional to carbon dioxide levels, being within the range of 7.0 to 9.5. Concentrations of dissolved oxygen covered a spectrum of values from 0.1 to 15.6 ppm, both highs and lows developing in the original lake basin area. During summer the mean concentration of dissolved oxygen in the lake was about 7.0 ppm.

The populations of benthic organisms increased through the spring with a peak abundance in August of approximately $6500/M^2$. The abundance decreased steadily through the fall and winter. Predominant orders were Diptera, Olegochaeta, Bryozoa, Ephemeroptera and Pulmonata.

In 369 plankton samples, we found large quantities of invertebrates. Liter samples were 62% protozoans, 21% cladocerans, 11% copepods, 5% rotifers and 1% ostracoda during midsummer. Plankton were nearly absent during April and early May. Population density increased in late May, peaked in August with a mean of 232 organisms per liter, then declined rapidly in the fall.

Relative abundance. The 47,500 fish caught in gill nets and trap nets were used to assess relative abundance of the 7 most common species (Fig. 3). The species catch per effort in all the gill nets was

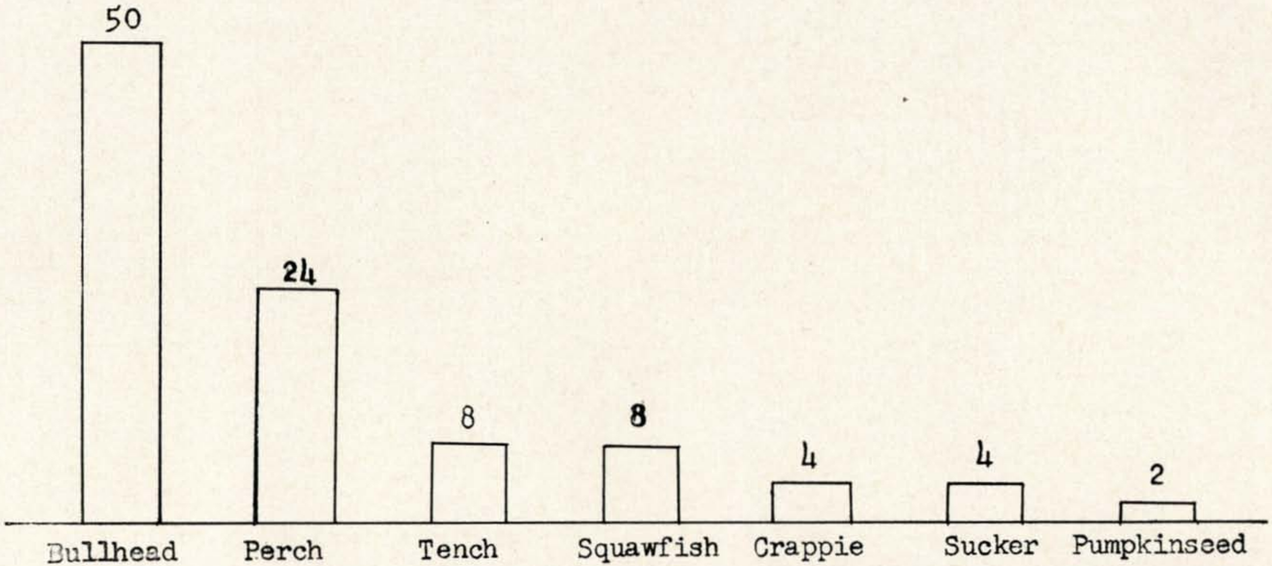

Figure 3. Percent relative abundance of species in catches of 47,000 fish taken in trap and gill nets.

individually computed and then averaged to give the overall percentage abundance in the nets. The species percentage in the individual trap nets was also computed and then averaged. The percent relative abundance in both gill and trap nets was then combined to give an estimate of the overall relative abundance. It is assumed that the number of each species of fish captured, relative to the amount of fishing effort expended, was a reasonable index of species abundance. The bullhead was the most numerous fish and when combined with the perch represented 74% of the total gill and trap net catch. Tench and squawfish respectively appeared next most abundant, followed in order by the crappie, sucker and pumpkinseed.

Seasonal abundance. The maximum abundance of perch was in May (Table 2) while the crappie were most abundant in June. In July the tench, pumpkinseed and squawfish were the most numerous. Bullhead and suckers were found in greatest numbers in August.

Movement. With the exception of perch and squawfish, most recovered tagged fish tended to remain near the point of tagging throughout the summer months. McCammon and Seeley (1961) noted that bullheads tagged in an arm of a large lake tended to remain in that arm. Ball (1944) also noted that bullheads remained in a limited area after tagging.

Perch showed no general movement patterns and appeared to range freely within the lake. Squawfish apparently moved down-lake throughout the sampling period. In the fall, when the water level was falling, the tagged fish recovered had moved down-lake into Lake Coeur d'Alene, and apparently dispersed widely. Two bullheads traveled more than 20 miles northward in the Lake Coeur d'Alene complex. Other bullhead, crappie, and perch had traveled lesser distances but were recovered in several different contiguous bodies of water.

Environmental correlates. Significant correlations ($P = 0.05$) between abundance of fish in the gill nets and certain environmental factors

Table 2. Seasonal abundance based on total catch during the period April to December 1965. Modal abundance is in heavy print.

	Month								
Species	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Perch	55	**235**	230	165	95	125	25	45	150
Bullhead	5	2400	5600	8400	**9000**	5600	1400	2000	1400
Crappie	0	560	**1240**	60	100	40	40	40	100
Tench	0	600	1240	**3400**	800	300	40	50	40
Pumpkinseed	0	10	30	**75**	10	5	0	0	60
Squawfish	5	40	105	**540**	365	220	50	70	55
Sucker	5	5	15	65	**160**	10	5	5	0
Total	70	3850	8460	12705	10530	6300	1560	2210	1805

were obtained from the IBM 1620 Stepwise Multiple Regression Analysis program. Only in the case of suckers (Table 3) was there no significant relationship between abundance and any enviromental factor. There were significant correlations between temperature and abundance of bullhead, tench, crappie, pumpkinseed, squawfish and perch. There were significant correlations between percent saturation of dissolved oxygen and abundance of bullhead, pumpkinseed, tench, crappie and squawfish. The relationship between abundance of perch and percent saturation of dissolved oxygen was nonsignificant. There was a negative correlation between abundance of both bullhead and crappie and the depth of light penetration. Crappie were most numerous in June, when light penetration was reduced due to turbidity from spring runoff. Bullhead were most abundant in July and August, when the bloom of **Anabaena** was maximal, reducing light penetration. The bullhead, being primarily a bottom feeder, also showed a significant positive correlation with numbers of benthic organisms. Plankton numbers were significantly correlated with the numbers of squawfish taken in the gill nets. Stomach samples taken from the squawfish contained many plankters during the summer when planktonic invertebrates were most numerous.

Table 3. Coefficient of correlation between abundance and environmental factors during the period April to December 1965. Significant value of "r" at the 5% level for temperature and dissolved oxygen is .239; for light, depth, turbidity, number of benthos and number of plankton it is .290.

Species	Light	Temperature	Dissolved Oxygen	Depth	Turbidity	No. Benthos	No. Plankton
Sucker	.180	.162	.066	-.101	-.095	.074	.006
Bullhead	.433*	.432*	-.311*	-.079	.055	.293*	.242
Tench	.275*	.299*	.153	-.075	-.249	-.148	-.113
Crappie	.294*	.291*	-.370*	.039	.201	.041	.081
Pumpkinseed	.353*	.341*	-.061	-.013	-.193	-.197	-.007
Squawfish	.364*	.314*	-.249	.070	.221	.006	.313*
Perch	.487*	.135	-.186	-.129	-.047	.177	.186

* Significant at 5% level.

DISCUSSION

Prior to the initiation of this study, there had been little intensive work done on Round Lake or any of the waters contiguous to the lake. Kemmerer **et al.** (1923) and Ellis (1932) both conducted general limnological studies in the Lake Coeur d'Alene area, but neither study was specifically directed at Round Lake.

Study of seasonal abundance and movements of the 7 most common species of fish in Round Lake has demonstrated that there is a definite interlake seasonal movement. Round Lake may be classified (Welch, 1952) as eutrophic. It provides an ideal warm-water spawning and rearing area for several fish species found in Lake Coeur d'Alene. It appears that the various fish populations move into Round Lake in the spring and early summer months as water temperature increases. There were significant correlations between abundance of all species (except suckers) and water temperature.

Percent saturation of dissolved oxygen was maximal during July and August and there were significant correlations of oxygen concentration with abundance of all species except the sucker and perch. The numbers of perch caught in nets decreased during August, then increased in the late fall, largely due to recruitment of young-of-the-year.

Depth of water, while not significantly correlated with net catches due to lack of netting during winter, seemed to strongly influence abundance and movement of fish. In late fall and winter, lake drawdown was rapid and the livable space in Round Lake was markedly reduced. When the water level in the fall began receding, tag recoveries of the several fish species indicated a general movement out of the lake. Moody (1957) conducted studies on a shallow lake with connecting river system in Florida and found that a gradual decline in total fish populations appeared to be directly related to a steady recession of water level in the lake. Greenbank (1956) noted that a lowering of the water level in the Mississippi River, with a resultant current flowing out of the backwaters, produced a movement of carp, northern pike, crappie, bowfin, and several other species. The movement was from the backwater toward the main river channel, i.e., with the current, and was intensified by a rapid drawdown. Greenbank noted that the fish appeared to be moving actively rather than being swept along by the current.

Tag recoveries outside of Round Lake have indicated that there is a wide dispersal once the fish reach Lake Coeur d'Alene. Many tags were recovered several miles from Round Lake.

We believe the Round Lake fish fauna is composed of seasonally abundant populations influenced strongly by environmental factors. Interactions between environmental factors (Table 3) showed positive correlations for temperature and dissolved oxygen and temperature and plankton. Negative correlations appeared for light and temperature, light and turbidity and light and plankton. As the temperature increased the percent saturation of dissolved oxygen and plankton increased. The latter reduced light penetration. Increased turbidity from spring freshets also reduced light penetration. The degree of interaction by these environmental factors is not completely understood by fishery workers, but the abundance and movement of the various fish populations in Round Lake can be correlated to water temperature, dissolved oxygen and depth. Casual relationships remain to be proven.

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LITERATURE CITED

Amer. Pub. Health Assoc. 1955. Standard methods for the examination of water, sewage, and industrial wastes. 10th ed. New York. 522 p.

Ball, Robert C. 1944. A tagging experiment on the fish populations of Third Sister Lake, Michigan. Trans. Amer. Fish. Soc. 74: 360-369.

Carlander, Kenneth D. 1942. An investigation of Lake of the Woods, Minnesota, with particular reference to the commercial fisheries. Minn. Dept. Cons. Fish Res. Inv. Rpt. No. 42(1): 1-155.

Crowe, W. R. 1950. Construction and use of small trap nets. Prog. Fish-Cult., 12(4): 185-192.

Davenport, R. W. 1921. Coeur d'Alene Lake, Idaho and the overflow lands. U. S. Geol. Surv. Water Supply Paper No. 500: 1-31.

Ellis, M. M. 1932. Pollution of the Coeur d'Alene River and adjacent waters by mine wastes. U. S. Dept. of Com., Bur of Fish. 136 p.

Greenbank, John. 1956. Movement of fish under the ice. Copeia, 3: 158-162.

Kemmerer, George, J. F. Bovard, and W. R. Boorman. 1923. Northwestern lakes of the United States; biological and chemical studies with reference to possibilities in production of fish. U. S. Bur. Fish. Bull. 39: 51-140.

McCammon, George W., Charles M. Seeley. 1961. Survival, mortality and movements of white catfish and brown bullheads in Clear Lake, California. Calif. Fish and Game, 47(3): 237-255.

Moody, Harold L. 1957. A fisheries study of Lake Pansoffkee, Florida. Quarterly Jour. of the Florida Academy of Sciences. 20 (1): 21-88.

Welch, Paul S. 1952. Limnology. McGraw-Hill Book Co., New York. 538 p.

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