# Thermal, Turbidity, and pH Conditions of The Upper White River: Sioux and Dawes Counties, Nebraska.

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# THERMAL, TURBIDITY, AND pH CONDITIONS OF THE UPPER WHITE RIVER: SIOUX AND DAWES COUNTIES, NEBRASKA.

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ABSTRACT: Research indicates inverse correlations between pH and turbidity when the sediment is primarily of an organic nature. Siliceous sediment does not follow the same curve. Definate influences of cultivated lands on water turbidity are shown in the lower portion of the study area. Temperatures vary considerably within short distances, with the cause only speculative at this time. The study gives basis for the inferences on preferred habitats of trout and catfish.

**INTRODUCTION:** The White River is an easterly flowing body of water originating in the buttes a few miles west of the town of Andrews, now abandoned. It angles through Crawford, and skirts to the north of Chadron, eventually draining into the Missouri River near Chamberlain, S.D.

My concern for the study came about through the observation that trout did not seem to be in evidence in the river north of Chadron, apparently due to adverse conditions beyond their tolerance levels since trout are stocked in the river above Crawford, and no other obvious barriers prohibit their dispersal downstream.

Applications of this type of study could be made by Fish and Game departments, Soil Conservation agencies, National Forest personnel, and sportsmen, all bent in the hopes of improving recreational opportunities and reducing erosion and pollution.

Problems encountered during the research include inadequate mapping of the region, with the only available source being a U. S. Geological Survey topographic map with 100 foot contour intervals, much too large to indicate subtle altitudinal variations, and as a result, temperature readings lose some of their importance. Another problem was the size of the study area, nearly 50 linear miles. Thus details had to be passed up, due to the time factor.

**MATERIALS AND METHODS:** A U. S. Geological Survey topographic map with 100 foot contour intervals was used as a reference for the profile maps, and also in determination of checkpoints, from which water samples and temperatures were taken. Easy accessability to the river was a main consideration in checkpoint designation, and places where bridges cross the water were preferred because of easiest location on the map for future reference.

The thermometer used was a standard Celsius laboratory-grade indicator, and it was suspended in the water to an arbitrary depth of six inches with the aid of a spincast reel and 6 lb. monofiliment line. Water samples were taken at the surface in a measuring cup, and transferred to 130 ml. wide-mouth bottles for the return trip to the lab.

Four different days were used to survey the river, with a starting point at the bridge north of Chadron on Highway 385, and proceeding upstream to the final checkpoint just above Andrews. On two consecutive days, and at roughly the same time, one stretch of the river was checked, and the 24 hour fluctuation was significant enough to encourage at least one trip covering the whole study area in one afternoon. This was done, and it is these readings that appear on fig. 1 of this text.

Two 5 ml. samples were taken from each collection bottle for the turbidity measurements, after each had been agitated sufficiently. They were then centrifuged for approximately two minutes in tubes that had been dried at 82° C. for 24 hours prior to the test. The centrifuged samples were dried in the oven at 82° C. for 24 hours to eliminate all moisture from the sediment, and the resulting weight difference was noted. The figures obtained were multiplied by 200 so that the results could be expressed in gms/liter.

The pH readings were taken with an electronic pH meter, which was standardized with a known buffered solution; it was checked intermittently for meter drift during testing with the same solution.

**OBSERVATIONS AND DATA:** (TEMPERATURE) It has been noted (Lager 1956) that the rainbow trout *(Salmo gairdnerii)* seem to function their best in waters between 5°-28° C., with gradual acclimation allowing them a slightly wider area of thermal conditions. Extreme temperatures tend to retard growth, and survival is limited to short periods in waters exceeding 28° C.

The brown trout *(Salmo trutta)* apparently have adapted to warmer water, and thus inhabit regions nearly intolerable to rainbow trout, though the variation is only a few degrees.

Although the actual source of the White River was not reached, readings taken a few miles downstream simulate a headwater condition (checkpoint 17). A series of springs enter the stream here and create a complex temperature situation, as can be seen on the profile map (fig. 1) and the checkpoint 17 map (fig. 3). Water is carried here in a limey-sandstone aquifer that is located in the cliff on the south bank. It is here that temperatures are their lowest, and trout seem most abundant, though they are all quite small. Planaria also inhabit the spring in great numbers, an evidence of reasonably pure water and abundant organic matter.

Downstream, thermal conditions become erratic, reaching a peak at the junction with Soldiers Creek, near Ft. Robinson. From here, they tend to decrease slowly to a reasonably low level north of Chadron. It would seem from temperature data that the consistently best habitat for trout is the region now void of them.

**OBSERVATIONS AND DATA:** (pH AND TURBIDITY) Some interesting correlations appear when reviewing fig. 2. A vertical line between checkpoint 6 and 7 separates the region containing mostly siliceous sediments on the

FIG. 2

PROFILE OF THE WHITE RIVER WITH pH AND TURBIDITY CORRELATIONS.

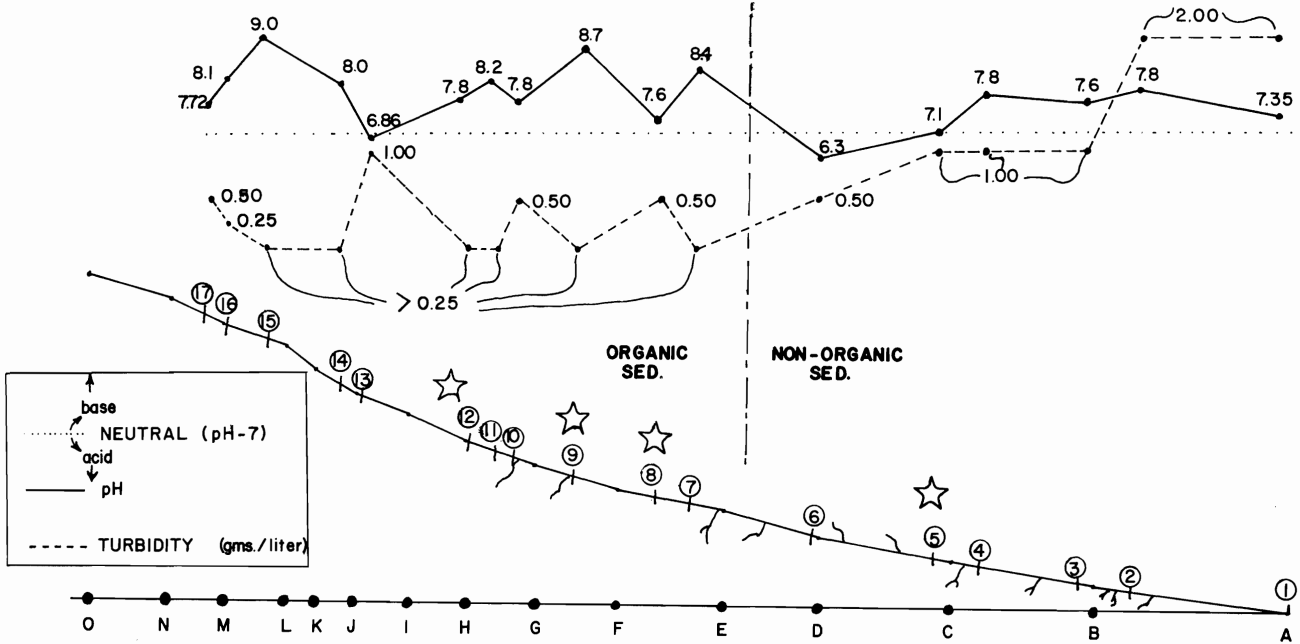


FIG. I
PROFILE OF THE WHITE RIVER WITH JULY WATER TEMPERATURES.

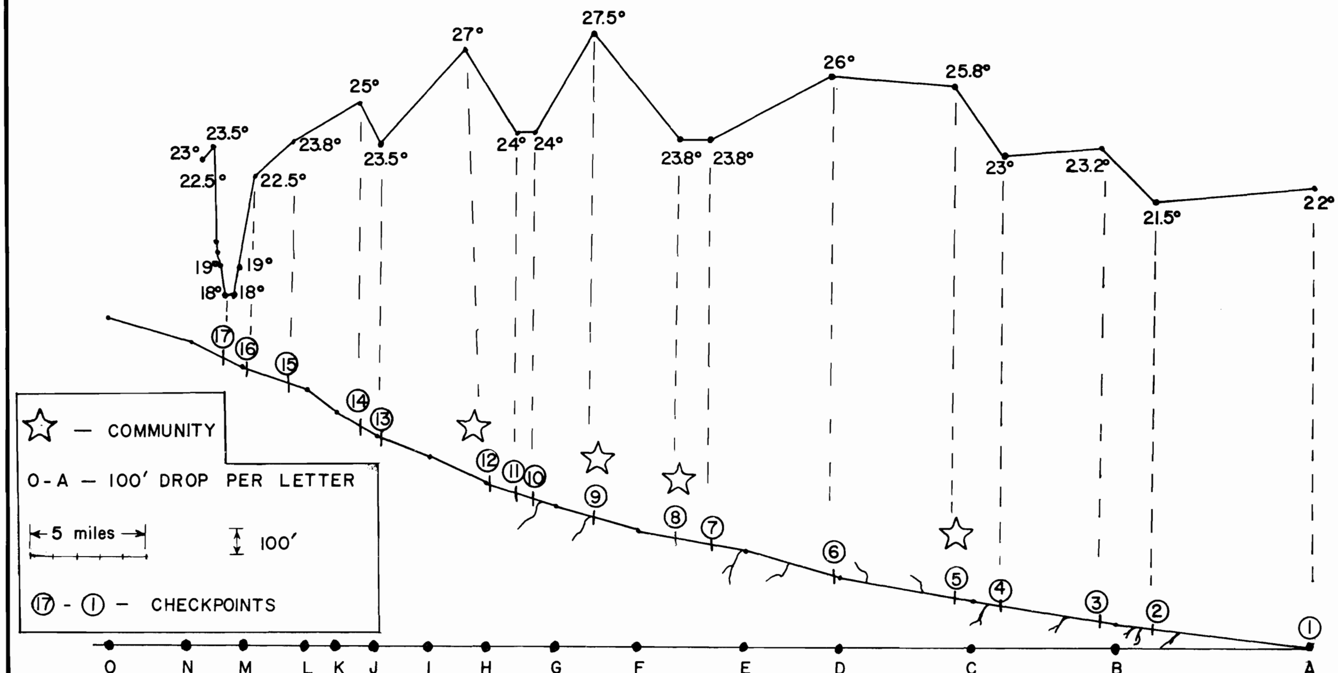
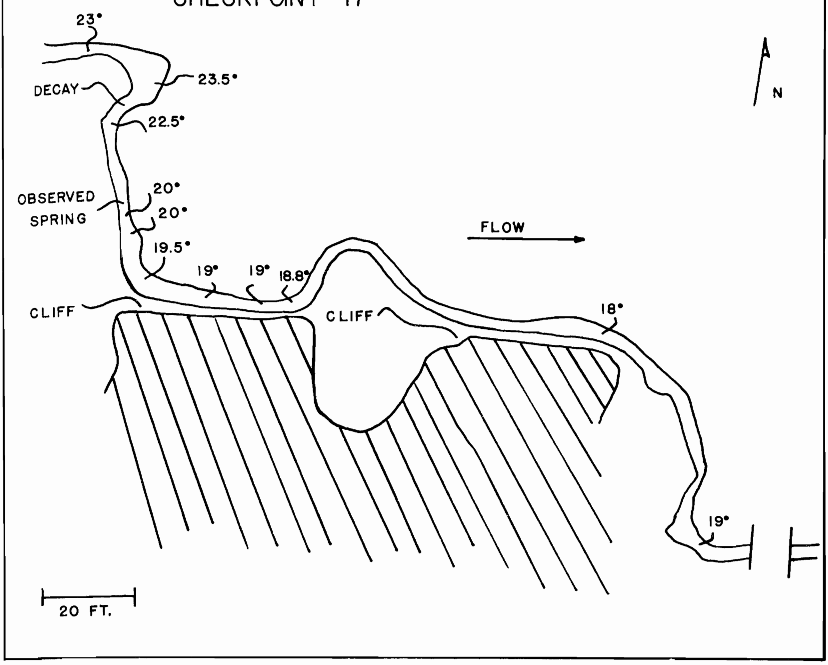


FIG. 3
CHECKPOINT 17




right from the region containing mostly organic sediments on the left. This vertical line refers only to the dashed lower graph line.

A horizontal dotted line indicates a pH of 7 (neutral) with acid readings below the line and basic readings above. This horizontal line refers only to the solid upper graph line.

When organic sediments are a. a high level, the pH tends to drop. Conversely, when organic sediments are at low levels, higher pH results.

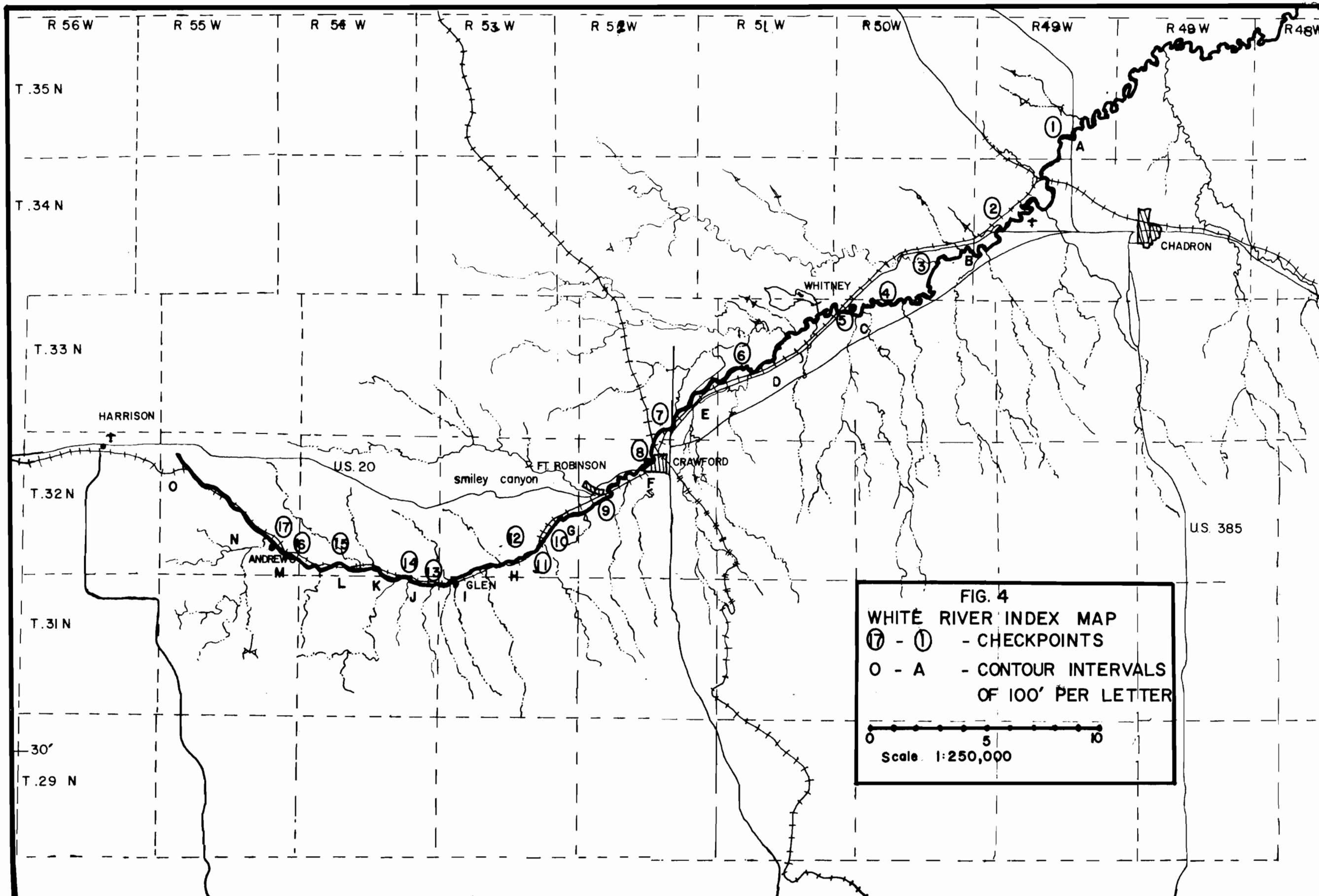
On the right side of the graph, siliceous sediment does not appear to have similar results. It is also interesting to note that siliceous sediment appears in the river only after it passes into the region of cultivated land, and the farther it proceeds, the higher the readings.

Checkpoint 6, west of Whitney, showed signs of detergent when agitated, a trait not exhibited by any other sample.

Correlations between temperature and pH/turbidity readings seem scant.

With dry sediment samples and concentrated HCl, carbonates were tested for, and the effervescence was noted to be greatest in samples also showing the highest pH.

Qualitative analysis revealed amounts of nitrates in all the samples, but a quantitative analysis was not attempted.


R 56 W
R 55 W
R 54 W
R 53 W
R 52 W
R 51 W
R 50W
R49W
R 49 W
R48W
T .35 N
T .34 N
T .33 N
T.32 N
T.31 N
30′
T.29 N
HARRISON
U.S. 20
smiley canyon
FT. ROBINSON
CRAWFORD
WHITNEY
CHADRON
U.S. 385
ANDREWS
GLEN
O
N
M
L
K
J
I
H
G
F
E
D
C
B
A
FIG. 4
WHITE RIVER INDEX MAP
17 - 1 - CHECKPOINTS
O - A - CONTOUR INTERVALS OF 100′ PER LETTER
0
5
10
Scale 1:250,000

**DISCUSSION AND CONCLUSIONS**: It has been stated (Smith 1966) that streams of an alkaline nature are the best suited for trout habitat, as nutrients are of the greatest abundance. Research on the White River seems to bear out this fact to a great extent, with the highest basic readings found in water that supports the majority of the trout. Carbonates are at their greatest levels, and natural vegetation is in adequate amounts.

Temperature does not seem to be as great a limiting factor by itself, as it does in conjunction with other variables, though it was stated by Avey (personal communication), that no trout are in evidence within the region of high temperature adjacent to and above Ft. Robinson during these months of peak solar radiation. Reasons for this extreme in temperature here is still a mystery, but it is thought to be due to a shallowing stretch below the municipal water reservoir serving Crawford. Between Ft. Robinson and Crawford, the water cools several degrees, and trout again appear and thrive.

It is fortunate to collect these data during a month of such warm weather, for it is also the period that shows the maximum water temperature reached throughout the year, which makes the thermal readings more meaningful.

In the lower stretches of the study area near Whitney, turbid water and a lack of aquatic vegetation seemed the predominant case. As it now would appear, this may have been the prime limiting factor. Successful reproduction in the genus *Salmo* requires a spawning ground with little silt, as high quantities of silt cause mortality of fertilized eggs. Accumulated silt in gills of adults would seem also to be a factor in their morality. Catfish, on the other hand, seem to coexist with the turbid waters, and as a result, are found abundantly in the lower region.

The upper portions of the river above Crawford are much clearer than the part of the river adjacent to the cultivated land downstream. The sediments that were encountered in the upper part include insect larvae, decomposing vegetation, and carbonates. Colloidal particles were also present, but their quantitative effects were not measurable. In no samples of the upper stream were siliceous materials found. This factor alone makes it a most desirable location for trout, all other factors being non-limiting.

Decay in some environments has a lethal effect on trout populations, as in a beaver dam that impounds water and decaying debris. Acid conditions result, and the trout that do remain are not of the high physical quality as surrounding, non-impounded populations.

Two parts of the river have acid conditions, and one of these corresponds to a high level of organic sediment, possibly there due to decay. The other acidic location is in the lower stretch (checkpoint 6), and if this condition is due to organic decay, it is masked by a predominance of the non-organic silt. This particular discovery was coupled with the presence of detergent in the water. I would expect also a high concentration of urea, feces, and other by-products of man's habitation under careless conditions. It is assumed that the introduction of suspected sewage is not far upstream from checkpoint 6, as it was not present at checkpoint 7.

It is known that survival of trout in flowing waters is brought about through many interrelated facets, including the many not studied in this project, but at least equally critical. High densities of humans tend to crowd out the genus *Salmo* if proper cautions are not exerted in sewage disposal and field erosion.

Improvement of the White River could be made through promotion of better tree cover, clogged water cleared of decaying material, controlled field run-off, and elimination of raw sewage disposal in the water. This is but one small example of an opportunity for man to enrich a natural environment to its full potential by elimination of human disturbance from outside activities.

**ACKNOWLEDGEMENTS**: The qualitative analysis and turbidity readings were made with the aid of Phil Warrick. Dave Ostergaard and Dave Avey, through familiarity with the river, gave many helpful suggestions and ideas, as did Dr. Hepworth and Dr. Agenbroad, both of Chadron State College. I thank them all most sincerely for their interest and time.

## REFERENCES CITED

Lager, Karl F., 1956. Freshwater Fishery Biology: Wm. C. Brown Co., pp. 202-215, 294-306.

Smith, Robert L., 1966. Ecology and Field Biology: Harper and Row, pp. 192-209, 596-603.