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The Influence of Goodenough Spring on Amistad Reservoir, Texas

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THE INFLUENCE OF GOODENOUGH SPRING ON AMISTAD RESERVOIR, TEXAS

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Goodenough Spring is a sub-lacustrine spring situated 43 meters beneath the surface of the international Amistad Reservoir on the Rio Grande. Its source is the Edwards-Trinity aquifer and prior to its inundation in 1968, it was a very high volume and high quality tributary to the Rio Grande. Since 1968, Goodenough Spring has been mixing with the more saline water of the reservoir. However, the mixing is not uniform, leading to horizontal lenses of spring water within the strongly stratified water column during the summer and surface infusion of spring water in the winter. Spring and fall are transitional periods. From a moving boat, we have tracked winter spring flows using simultaneous 1 Hz measurements of temperature, turbidity, in vivo chlorophyll fluorescence, conductivity, pH and GPS readings. This sampling rate yields a 10 m resolution along the transects. Subsurface water column structure was inferred from spot profiles of these same parameters reading at 1 meter depth intervals at 15 locations. Goodenough Spring carries a significant NO3-N load and discharges it into the reservoir at a point far removed from other major nitrogen inputs. Water samples were also collected along the transects for subsequent NO3-N analysis. Our data indicate that Goodenough Spring is a significant contributor to the quality and quantity of water in Amistad Reservoir.

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The Influence of Goodenough Spring on Amistad Reservoir, Texas.

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Goodenough Spring is a sub-lacustrine spring situated 43 meters beneath the surface of the International Amistad Reservoir on the Rio Grande. Its source is presumably the Edwards-Trinity aquifer and prior to its inundation in 1968, it contributed a large flow of very high quality water to the Rio Grande. Since 1968, Goodenough Spring has been mixing with the more saline water of the reservoir. However, the mixing is not uniform, leading to horizontal lenses of spring water within the strongly stratified water column during the summer and surface infusion of spring water in the winter. Spring and fall are transitional periods. We have tracked winter spring flows using simultaneous 1 Hz measurements of temperature, turbidity, *in vivo* chlorophyll fluorescence, conductivity and GPS readings. From a running boat, this sampling rate yields a 10 m resolution along the transects. Subsurface water column structure was inferred from spot profiles of these same parameters reading at 1 meter depth intervals at 15 locations. Since Goodenough Spring carries a significant NO_3-N load and discharges it into the reservoir at a point far removed from other major nitrogen inputs, water samples were also collected along the transects for subsequent NO_3-N analysis.

During several days in the summer of 2005, volunteer SCUBA divers collected water samples and deployed water quality and flow measurement instruments within the spring cavern. The data obtained from these operations provide insight into the processes which must be occurring in order for the surface boil to have the physical and chemical characteristics that were measured. Specifically, the spring water, which is characterized by low specific conductance and high temperature, is entraining and mixing with a layer of water characterized by relatively high specific conductance and low temperature to yield a plume of water with intermediate characteristics very similar to the surface water. When the mixed plume of water is of lesser density than the surface water, the surface boil is strongly present. When the mixed plume of water is of greater density than the surface water, but the lake is not strongly stratified, the plume of water will often weakly break the surface due to inertia and be evident in several meters surrounding the boil, but apparently sinks back beneath the surface. When the mixed plume of water is of greater density than the surface water and the lake is strongly stratified, no surface boil is present and the plume only rises into the metalimnion before spreading out at mid-depth.

As a water resource, the unmixed water from Goodenough Spring is very high quality for municipal or agricultural use. However, it is immediately mixed with lower quality water containing salinity from the Pecos and Rio Grande rivers. Goodenough Spring is an important example of the large influence that springs and seeps from the Edwards-Trinity aquifer, which feed the Rio Grande, the Pecos and the Devils rivers, have in diluting the salinity of the International Amistad Reservoir which would otherwise tend to be too salty for human consumption or agricultural use.

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