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EFFECTIVENESS OF SEALING SOUTHEASTERN ARIZONA STOCK PONDS WITH SODA ASH[1/]

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INTRODUCTION

Stock watering ponds are a primary source of water for livestock on rangelands in the southwestern United States. In areas with calcareous soils, seepage rates from these ponds may be excessive, and pond use limited to relatively short periods following runoff-producing thunderstorm rainfall. Applications of sodium salts, primarily sodium chloride, have been used for many years to reduce seepage. However, most early efforts were based on trial and error (Decker, 1963). Because pond seepage losses are a particularly serious problem in the semiarid Southwest, scientists at the USDA Water Conservation Laboratory in Phoenix, Arizona set out in the 1960's to develop a systematic approach to reducing pond seepage. This effort included lab and field tests and establishing criteria for treatment.

Calcium causes normally well-dispersed clay particles to aggregate and increase the porosity of stock pond sediments. Sodium disperses the clay aggregates, which tend to seal soil pores. In laboratory tests the Water Conservation Laboratory scientists found sodium carbonate (soda ash) to be the most effective and long-lasting sodium salt for dispersing the clay aggregates and fixing calcium as calcium carbonate. Field tests substantiated the lab tests. Treatment guidelines published several years later (Reginato, Nakayama, and Miller, 1973) included estimating the water loss before treatment and the area to be treated, determining the depth and clay content of the pond sediment, and testing to see if the cation exchange capacity was sufficient for sealing. The guideline also suggested that regular maintenance was needed to prevent increasing seepage rates with time. The suggested maintenance involves adding soda ash regularly (every 2 or 3 years) to neutralize additional calcium carried into the pond in runoff.

PROCEDURE

Following lab tests in the USDA Water Conservation Laboratory in Phoenix, two "leaky" ponds on Walnut Gulch, 63.207 and 63.223 (Fig. 1), were treated with soda ash in 1968. Tests indicated that both the clay content and the cation exchange capacity were sufficient, that one could expect good results from soda ash treatment. The soda ash was broadcast over the dry pond surfaces to the spillway elevation at the rate of 3365 kg/ha, and mixed with the pond sediment to about the 10-cm depth with a disc. Water level recorders had been installed at both ponds several years before, so treatment results could be verified. Two late-season 20-day recession periods from an instrumented, unsealed, low-seepage pond, 63.214, are shown in Figure 2 for comparison with the records from the treated ponds.

RESULTS

The water level records at pond 63.207 were excellent, and provided a continuous record of seepage losses (Fig. 3). Seepage losses before and after treatment are shown, along with an estimate of surface evaporation based on pan evaporation (pond evaporation was estimated to be 70% of pan evaporation). Seepage losses were compared following the summer rainy season, and generally represent 20-day periods in September or October when the summer "monsoon" rains have ended. During this period, the number of days until the stock pond goes dry becomes critical. The late season seepage loss for the after-treatment period each year from 1968 through 1974 was reduced about 50%. No soda ash was applied to pond 63.207 after 1968, indicating that the treatment was considerably longer-lasting than anticipated.

Seepage losses in 1975 and 1976 could not be calculated accurately because pond 63.207 received little runoff. In 1977, there was no significant inflow until September; then a single storm raised the pond level sufficiently for subsequent seepage losses to be estimated. Seepage loss after this storm was about the same as before treatment in 1968 (Fig. 3). Because of the preceding long dry period, however,

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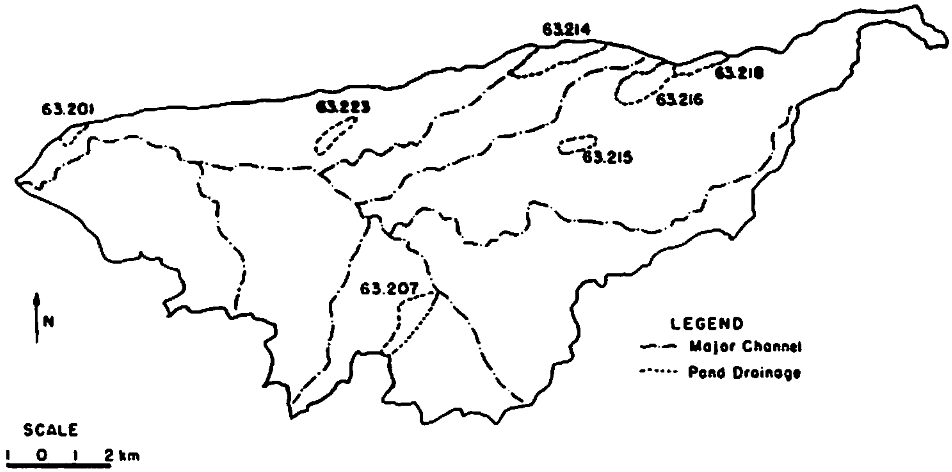

Fig. 1. Location of stock watering ponds on the Walnut Gulch Experimental Watershed, Arizona.

it is uncertain whether this represents a permanent return to the original "leaky" conditions or whether the increased seepage was due to pond sediment cracking and increased water absorption by the more recently accumulated untreated sediment. Hopefully, the 1978 summer's rain will produce sufficient runoff into pond 63.207 to compare seepage losses under similar conditions with those in the early 1970's. A best guess at this time would be that the pond will reseal, but possibly not as effectively as in the years immediately after treatment.

Water level records from pond 63.223 indicate that water losses were reduced after treatment. However, the water level records were inconsistent, and the magnitude of reduced losses is uncertain.

In 1970, composite sediment samples from four additional "leaky" stock ponds were analyzed for cation exchange capacity (CEC) and exchangeable sodium percentage (ESP). The CEC for all 4 ponds was above the minimum (15 meq/100 g) indicated in the Water Conservation Lab guidelines, but that of two of the "leakiest" ponds, 63.201 and 63.215, was just barely above the minimum (Table 1). The ESP was relatively low for 2 of the 4 ponds (Table 1).

TABLE 1. Cation exchange capacity and exchangeable sodium percentage values for composity 0- to 0.2-foot samples.

Stock Pond Number	Cation Exchange Capacity	Exchangeable Sodium Percentage
	(meq/100 gm)	
63.201	17.7	0.19
63.215	19.0	0.13
63.216	27.3	0.16
63.218	36.2	0.12

ADDITIONAL LAB TEST

Based on these analyses, we took composite pond bottom samples from each stock pond for seepage tests in the lab. Two samples, one to be treated and one to be left untreated, were taken from each composite sample and packed as uniformly as possible by hand into glass tubes. The amount of salt to be added to the water for the "treated" samples in the form of 0.5 molar sodium carbonate was determined from the following formula:

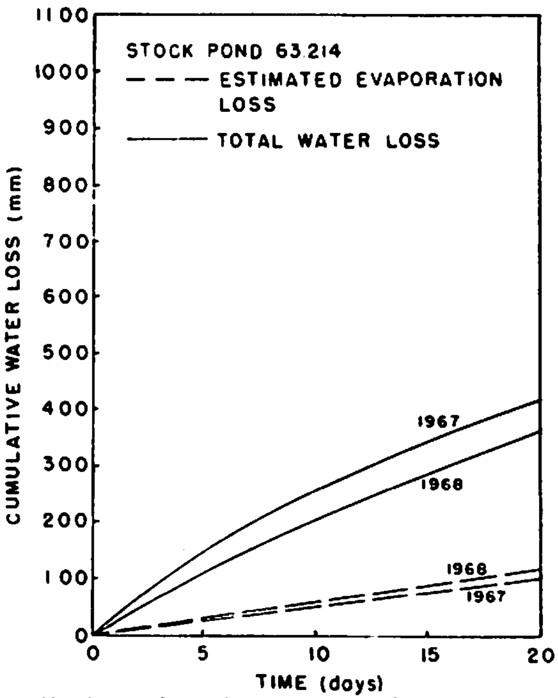

Fig. 2. Cumulative late-season water losses from untreated Pond 63.214, Walnut Gulch, Arizona.

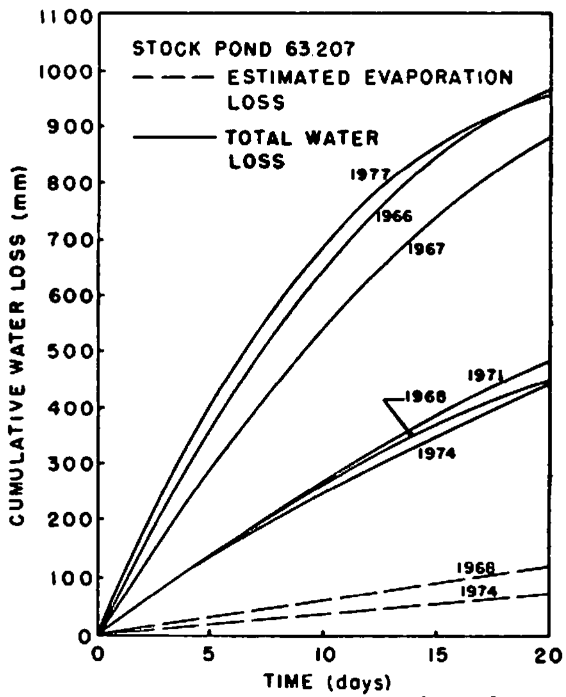

Fig. 3. Cumulative late-season water losses from treated Pond 63.207, Walnut Gulch, Arizona.

$$\frac{CEC \times W}{100} = M$$

where W is the weight of the sample in grams, and M is the number of milliliters of salt solution. The same amount of distilled water was added to the treated and the untreated sample at the beginning of the test.

The amounts of water or salt solution moving through the samples in the glass tubes are shown in Table 2. Although no exact relation can be established between infiltration rate reduction in pond sediment and infiltration reduction for a disturbed sample in a cylinder, a considerable reduction in head absorption rate indicates a reduced infiltration rate. The results suggested that all 4 ponds could be successfully treated, but with differing degrees of effectiveness.

TABLE 2. Relative rates of head absorption for eight samples in identical glass cylinders.

Stock Pond Number	Treatment	Elapsed Time	Cumulative Head Absorbed
		(min.)	(cm)
63.201	None	0	0
		31	2.0
		76	3.5
		144	5.0
	Salt*	0	0
		390	2.0
		4248	3.5
63.215	None	0	0
		16	2.1
		58	3.6
		104	5.1
	Salt	0	0
		137	2.1
		717	2.4
63.216	None	0	0
		29	1.8
		75	3.3
	Salt	0	0
		381	0.7
		1383	1.5
63.218	None	0	0
		28	1.8
		75	3.3
		134	4.8
	Salt	0	0
		33	0.5
		706	1.3
		1384	2.1
		2068	2.7

*Sodium carbonate.

ADDITIONAL TREATMENT AND RESULTS

Pond 63.215, the leakiest of the four ponds, was treated at the rate of 3365 kg/ha in the spring of 1971. The water level records do suggest that the treatment reduced seepage (Fig. 4), but the period following treatment was unusually dry, and the results are not as conclusive as those in the previous example.

Pond 63.201 was treated with soda ash at a rate of 3365 kg/ha in the spring of 1977. The data after one rainy season indicate that the treatment reduced seepage to about one-third of that before treatment (Fig. 5). However, several years of record will be needed before the overall effectiveness can be ascertained.

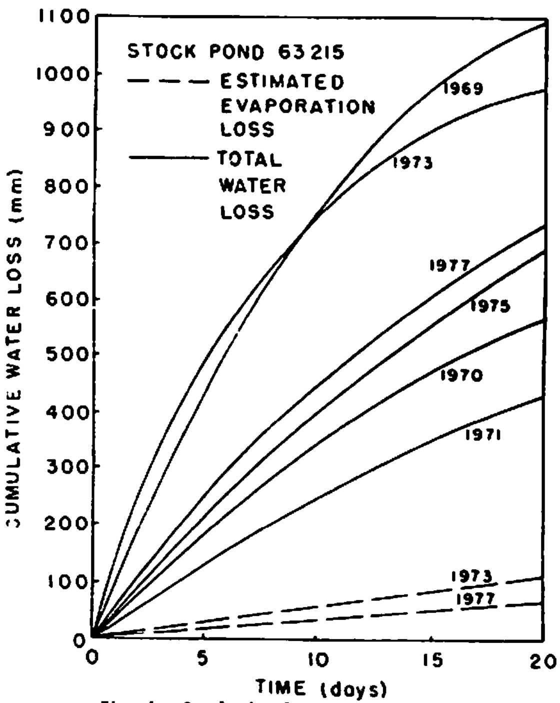

Fig. 4. Cumulative late-season water losses from Pond 63.215, Walnut Gulch, Arizona.

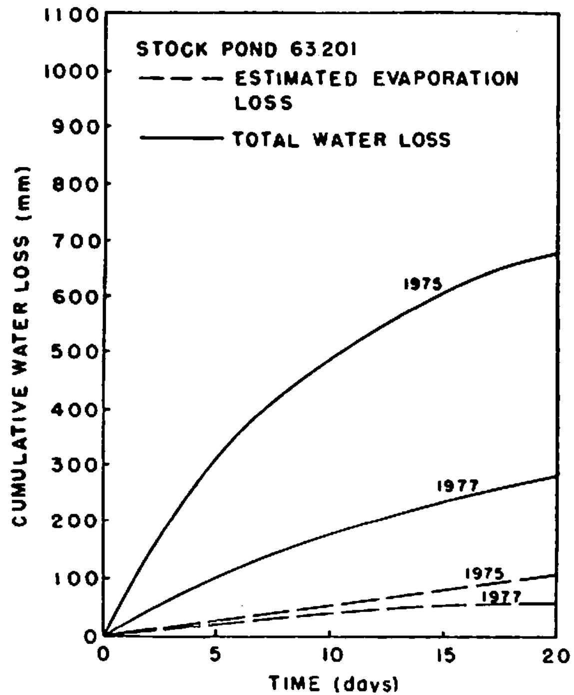

Fig. 5. Cumulative late-season water losses from Pond 63.201, Walnut Gulch, Arizona.

BENEFITS

Water level records at ponds 63.201 and 63.207 indicate that water losses were reduced appreciably after treatment with soda ash (Figs. 3 and 5). For example, the average 20-day water loss from stock pond 63.207 (the largest of the two ponds) was reduced from about 2800 m^3 to about 1500 m^3, a savings of 1300 m^3 (Table 3). Assuming that cattle drink about 0.04 m^3 of water per day, the increased available water amounts to 32,500 animal days.

TABLE 3. Water volume loss before and after soda ash treatment for two stock watering ponds on Walnut Gulch and estimated benefits of treatment.

Pond	Water Loss Before Treatment (m^3)	Water Loss After Treatment (m^3)	Water Savings (m^3)	Number of Animal Days*
63.201	500	200	300	7900
63.207	2800	1500	1300	34300

1 Animal Day = 0.04 m^3 water/day.

For pond 63.201, the increased available water amounted to 300 m^3 for the 20-day period, which amounts to 7500 animal days of water. More important, water remained in both ponds well into the spring rather than drying up during the late fall or early winter, thus providing the ranchers with more options to best utilize their range forage. Treatment cost was $200 for the soda ash, and $60 for application and discing.

SUMMARY

Treatment of "leaky" stock ponds with soda ash based on guidelines established by the USDA Water Conservation Laboratory has been successful for at least two ponds on the Walnut Gulch Experimental Watershed in southeastern Arizona. The treatment on one pond seems to have lasted much longer than anticipated, thus increasing the value of the treatment. A pretreatment laboratory seepage test is suggested to better determine the likelihood of treatment success. Additional water level records from already treated ponds in the next few years should provide a basis for a more quantitative economic evaluation of the method.

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