SURFACE WATER QUALITY IN TREASURE VALLEY IRRIGATION CANALS IN RELATION TO FSMA STANDARDS FOR WATER TESTING – 2017

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Introduction

The Produce Safety Rule of the Food Safety Modernization Act (FSMA) that regulates the production and harvesting of fresh produce begins to go into effect in 2018. Standards for determining the microbial quality of agricultural water are still under consideration by the Food and Drug Administration (FDA). As of this writing, the FDA is considering extending the compliance dates and potentially revising the standards to simplify them (https://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm546089.htm).

A major concern with the water testing provisions is how extensive the microbial testing for agricultural water will need to be. The current draft version of the agricultural water standards would require the establishment of water quality profiles for each source of agricultural water used during the growing of onions or other covered produce. Agricultural water is defined by the FDA as water that is directly applied to growing produce, which includes irrigation water and water used for pesticide applications. Separate water quality profiles would be required when there is "known or reasonably foreseeable hazard" that would lead to a change in water quality. This condition could result in very fine scale water testing, with individual farms having multiple water profiles depending on layout of their fields and the sources of their spray water.

Under the current draft rules, growers would be required to establish water quality profiles based on 20 water samples. If the geometric mean of the most recent 20 samples exceeds 126 colony forming units of generic *E. coli* per 100 ml of water (CFU/100 ml) and the statistical threshold value of those samples exceeds 410 CFU/100 ml of water, growers would be required to take some type of mitigation measure. The most practical mitigation measure for onion growers would be to allow for a microbial die-off period before harvest. The draft rules would allow a die-off rate of 0.5 log per day for up to 4 days following the last irrigation.

Although each farm would be required to maintain their own water quality profiles, there are provisions in the FSMA rules for sharing of water test results and for allowing third parties to collect water samples.

The FDA has indicated that testing could be done at larger geographic scales rather than a farm-by-farm or field-by-field basis if it can be scientifically demonstrated that data collected at those broader scales reliably characterize water quality. Such a region-wide data collection program could significantly reduce the burden on individual growers to collect water samples.

Potential Impact

The FDA has indicated that some form of water quality monitoring will be required for compliance with the produce safety rules of FSMA. Field configurations and the complexity of irrigation systems in the Treasure Valley could mean individual farms would need significant numbers of separate water quality profiles.

Developing a regional approach that samples water at broad geographic levels and that shares data among farms would significantly reduce the cost and time investment for individual growers.

In this study, water quality profiles were developed over a 2-year period for multiple sites along three major canals that provide irrigation water to a large proportion of onion fields in the Treasure Valley. These were the Old Owyhee Ditch in Malheur County, the Owyhee Irrigation District's "Shoestring" Canal in Malheur County, and the Farmers' Coop Canal in Canyon County, Idaho. The Shoestring Canal is supplied by water from the Owyhee Reservoir, water pumped from the Snake River and return flows. The Old Owyhee Ditch is supplied from the Owyhee River, Owyhee Reservoir, the Snake River, and return flows from other canal systems. The Farmers' Coop Canal is supplied by a diversion from the Boise River, which itself flows through agricultural areas. The data (n = 20 samples from each of 48 sites) were then used to generate other profiles based on different geographic parameters.

Materials and Methods

For each canal, four sampling "zones" with four sample sites within each zone were established (n = 16 sites per canal). Sample sites within zones were separated by 1 km (0.62 miles), and there was approximately 7 km (4.5 miles) between zones. These distances covered almost all of the lengths of each canal used for irrigation, with the intent to characterize water quality throughout each system. To comply with the proposed FSMA standards, sites were sampled a total of 20 times over 2 years (2016 and 2017). Canals were sampled from late July to early September to satisfy the FDA requirement that samples are collected as "close to harvest as practicable".

In addition to locating the sample sites, all places where water returned into each canal from drains or other inlets were identified and mapped.

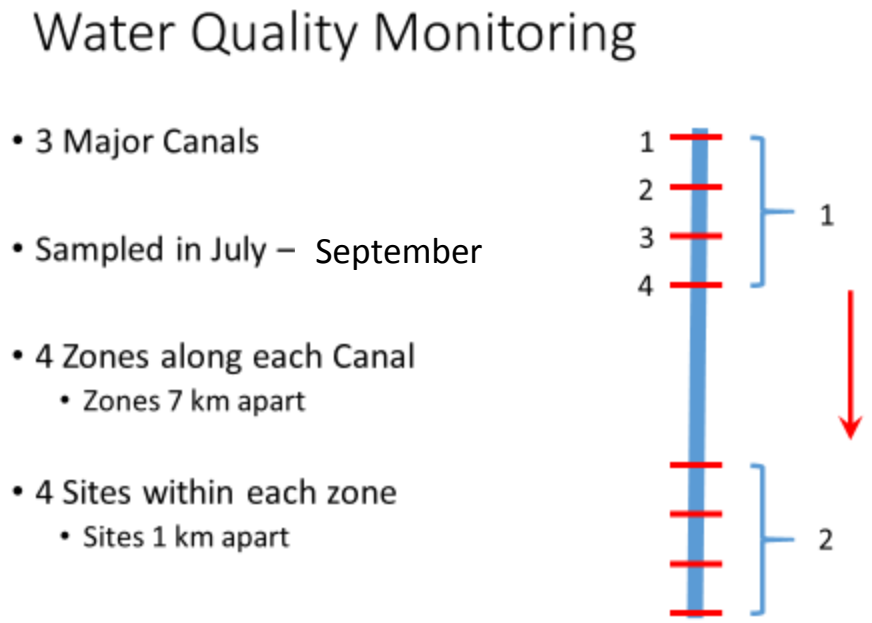

Figure 1. Schematic of water monitoring plan showing the arrangement of sampling sites within sampling zones.

Water quality profiles were developed for each canal to determine how variable results were among sites within and among zones. The water quality profiles were recalculated with the FDA die-off provisions (0.5 log per day die-off over 4 days). This 2-log reduction translates into a final level 1% of the original level.

Water quality profiles based on the actual sample data were expected to be highly variable with a large proportion potentially not within the FSMA thresholds (GM $\leq$ 126, STV $\leq$ 410 CFU/100 ml) (GM = geometric mean, STV = statistical threshold value). However, when recalculated with the die-off allowance (log(CFU) – 2), all sites were expected to be well within standards.

RESULTS

The sampling sites encompassed nearly the entire length of each canal. We mapped several hundred return points in the systems. The runoff from these points may potentially lead to increases in the bacterial load of the water in each canal. In general, the canals had different water quality characteristics.

Each canal flows through intensive agricultural areas with numerous return flow points. Even with these similarities, each canal had different patterns and levels of generic *E. coli* levels (Fig. 2). Canal 3 had the overall highest generic *E. coli* levels and the most variable data. Upstream sites on Canal 3 had low mean *E. coli* levels, but its downstream sites had the highest levels (Fig. 2). These patterns led to significant differences among the sampling zones on Canals 2 and 3; however, there were no differences among the sampling zones on Canal 1.

Although there were differences in water quality profiles among the different zones on Canals 2 and 3, there were no significant differences in profiles within each of the zones. This same pattern held for Canal 1. In fact, there were no differences in the profiles within or among zones. This finding suggests that sampling over larger geographic areas (e.g., 2-6 miles among testing locations) would be as representative of water quality as field-by-field sampling.

The majority of profiles for each of the canals had GM > 126 MPN / 100 or STV > 410 MPN / 100 ml or both, and thus exceeded the proposed FSMA standards (Figs. 3 and 4). However, after the 4-day die-off period, all profile sampling sites were well within the proposed FSMA standards. All of the sampling sites had profiles within the proposed standards within just 1-2 days of die-off.

Importantly, there was little variation among sample sites within each zone (Figs. 2 and 3). With the die-off provisions, large-scale geographic testing of water should adequately characterize the quality of different canal systems (Fig. 4). These results raise the potential that FSMA-related water testing could be done on a regional basis and growers can share water testing results. This could reduce some of the water testing burdens and costs on individual growers.

With Idaho-Eastern Oregon Onion Committee and grower association approval, information will be communicated to FDA to determine if broader scale monitoring would be an acceptable approach.

ACKNOWLEDGMENTS

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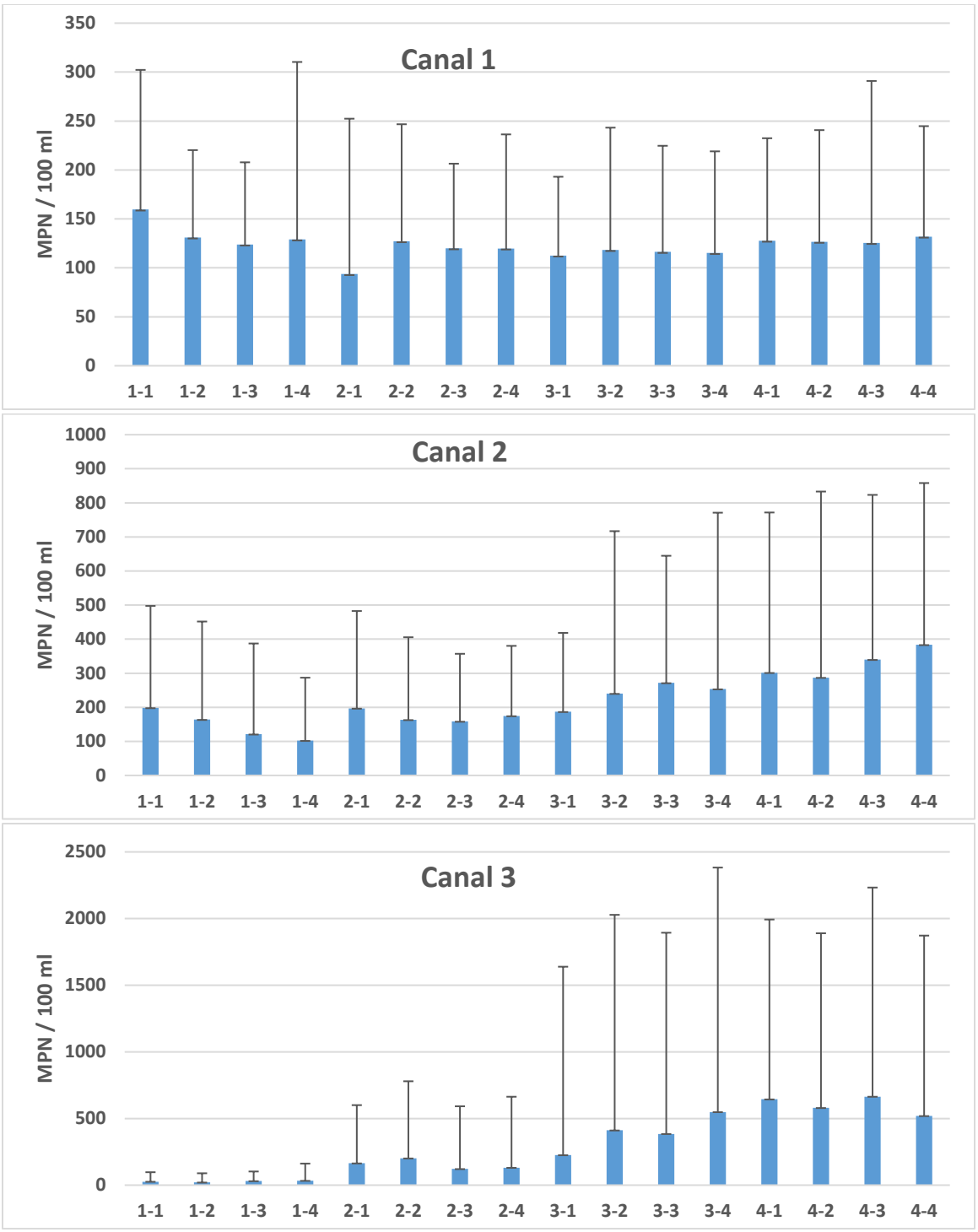

Figure 2. Water quality profiles for each sampling site along different canals. The first number in the site ID refers to the sampling zone (1 = upstream, 4 = downstream). The second reference number refers to site within zone (1 = most upstream, 4 = most downstream). Bars represent the geometric mean (GM); lines above bars represent the statistical threshold value (STV) for each site's profile. Note the different scales on each graph.

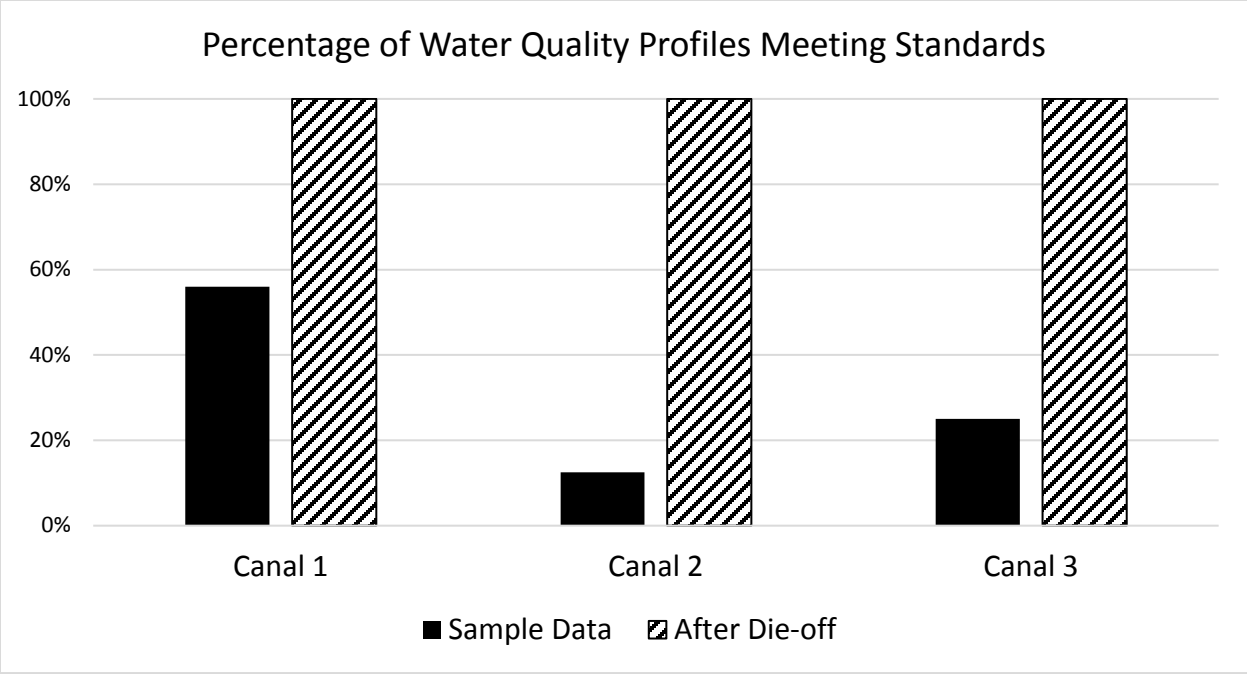

Figure 3. Percentage of water quality profiles that were within the proposed FSMA standards. All profiles were within the standards after allowing for die-off (hatched bars). Initial profiles based on the actual data show that only 13-56% of the profiles were within the proposed FSMA standards.

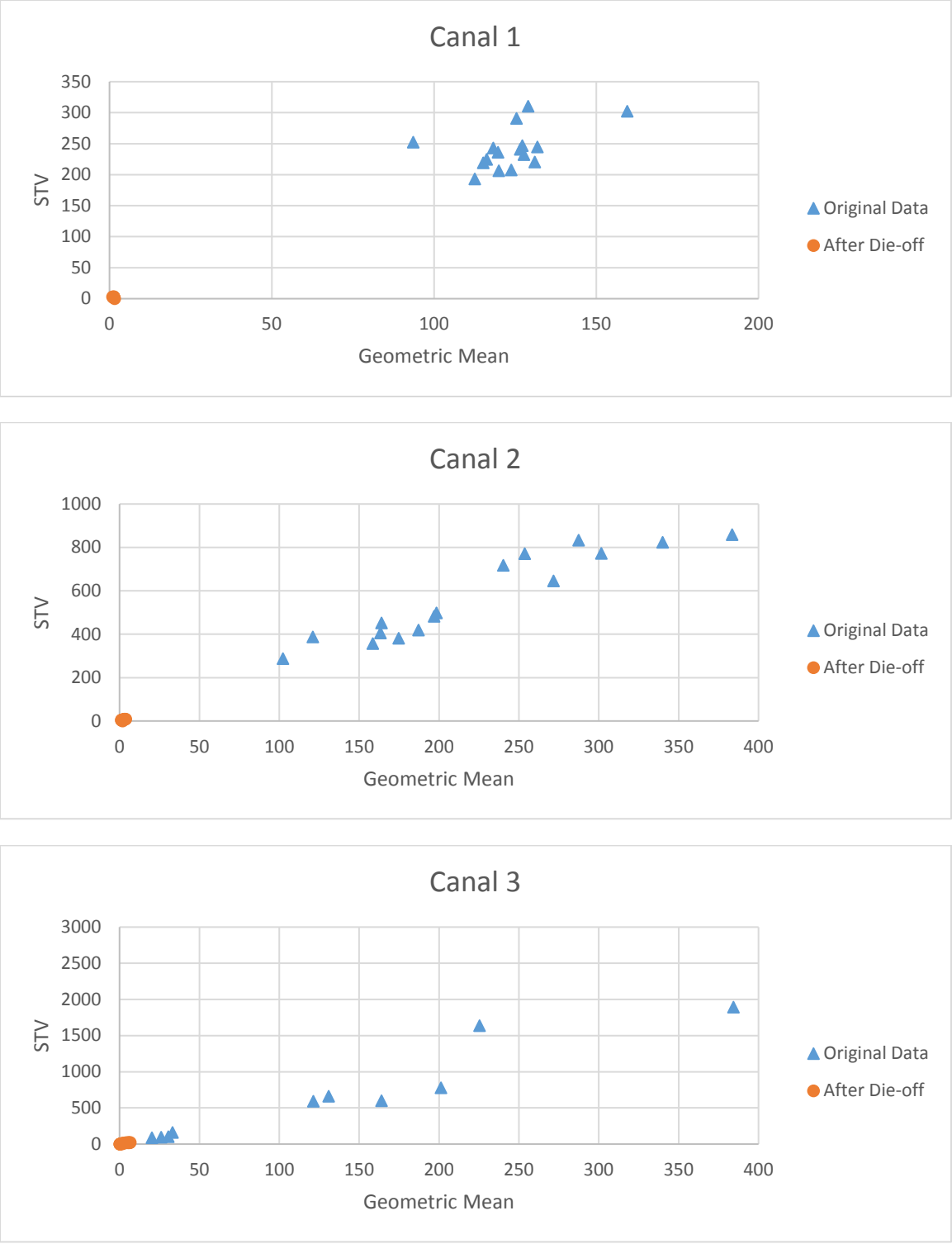

Figure 4. Water quality profiles based on original sample data (triangles) and after a 4-day die-off allowance (circles). Profiles with geometric mean (GM) ≤ 126 and statistical threshold value (STV) ≤ 410 meet the proposed FSMA standards. All profiles met the standard after the die-off period.