

**FINAL PROJECT PROPOSAL****(First year report -extended)****Project Title:** Understanding and managing the food safety risk of packline brushbeds

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\*Faith Critzer will assume PI in January 2018.

**Cooperators:** Six packing facilities in Washington**Total Project Request: Year 1:** \$51,966**WTFRC Collaborative expenses:**

Item	2017
Salaries & Benefits	\$2,736
Wages	\$3,472
Benefits	\$729
Travel	\$4,180
<b>Total</b>	<b>\$11,117</b>

**Footnotes:** Salary and benefits for Ines Hanrahan; Wages and benefits for intern.**Budget 1**

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Item	2017
Wages	\$6,256
Benefits	\$1,314
Equipment	\$11,000
Supplies	\$16,707
Travel	\$5,574
<b>Total</b>	<b>\$40,850</b>

**Footnotes:** Wages and benefits for technical assistant; Equipment is incubator ovens, plate counter and pipettes; Supplies for microbial test plates and sponges.

## 1. Objectives

1. Compare current brush cleaning and sanitation procedures in five (expanded to six) apple packing houses in Washington to determine the effectiveness of these procedures.
2. Determine if fruit sanitation practices are adequate to reduce the risk of cross-contamination from wax brushes during a production shift.
3. Determine if wax brushes are a commercially significant source of spoilage organisms (yeasts and molds)
4. Determine if there is a difference between the packing organic and conventional fruit in the above objectives.
5. Conduct appropriate food safety extension outreach with the apple packing industry

## 2. Significant Findings

- Newer lines generally had lower microbial counts than older lines, because of higher counts on the wax brushes of older lines. In this regard, ATP monitoring can be used to indicate when these brushes should be cleaned more intensively or even replaced.
- Lines with higher aerobic colony counts tended to have higher counts of coliforms, *E.coli*, yeasts and molds, and *Listeria* species.
- Clean out of place (COP) steam cleaning was very effective in reducing microbial counts on packing line brushes – aerobic colony counts were 1700 times lower than the average of the other five packing facilities.

## 3. Methods

Six representative apple packing facilities in Washington were selected for this project, partly based on responses from a project pre-survey. Packing facilities are numbered to maintain confidentiality (Table 1). Brushes and other packing line surfaces (oven rollers, drying oven walls, belts, curtains and transfer rubbers) were swabbed (3M™ Quick Swab) both before and after a production shift. The focus of the study was drying and wax brushes, but also included other brushes and surfaces in the wet area of the packing line.

Fruit samples were taken off the line before and after the brushbed at the start and end of the production shift; 10 fruit were taken at each location. Swabs and fruit were stored in a cooler box with ice packs during transportation from Yakima or Wenatchee, stored in a refrigerator overnight, and plated the following morning at WSU IAREC in Prosser. Fruit were placed in buffered peptone water incubation pouches for 1 h before plating.

The following microbial tests were conducted on swabs using 3M Petrifilm™ plates: aerobic colony count, coliform/*E.coli*, environmental *Listeria*, and yeasts and molds following the 3M Petrifilm methods for each test. The same tests were conducted on fruit samples, except that environmental *Listeria* and coliforms/*E.coli* testing were omitted. Enumeration was done using a 3M Petrifilm Plate Reader. Samples were diluted 1:10 using Butterfields solution for ACC and yeast and molds if high microbial loads were anticipated.

**Table 1: Packing facility numbers and description**

	Packing Facility Number					
	1	2	3	4	5	6
<b>Relative Age of Line</b>	Newer	Older	Newer	Newer	Older	Newer
<b>Wet/Dry Separation</b>	Yes	No	Yes	No	No	Yes
<b>Hygiene Monitoring</b>	Yes	No	Yes	Yes	Yes	Yes
<b>Brush CIP/COP</b>	CIP & COP	CIP	CIP & COP	CIP	CIP	COP
<b>Brush Cleaning Method</b>	Chlorine foam	Chlorine foam	Chlorine foam	Chlorine foam	Chlorine foam	Steam
<b>Sanitizer during Production</b>	Ozone, PAA, ClO <sub>2</sub>	PAA	Ozone, PAA, ClO <sub>2</sub>	PAA	Ozone	PAA

CIP, Clean in Place; COP, Clean out of Place; PAA, Peracetic acid.  
Newer lines < 5 years old; Older lines >15 years old

## 4. Results & Discussion

### 4.1. Environmental Listeria

Only facility 5 (older line) had environmental *Listeria* detections in 2017. These detections were on:

- a transfer rubber at the end of shift (10/2),
- soap brushes and a felt fabric transfer curtain at the start of shift (10/30), and
- a wax brush at end of shift on 10/30.

This facility had high aerobic colony counts at the start and end of shifts (Figure 2).

### 4.2. Coliforms & *E.coli*

Coliforms were detected at least once at all packing facilities at the start of the production shift (Figure 1). Areas that regularly tested positive for coliforms at the start of the production shift were:

- Wax brushes
- Transfer brushes after the drying oven
- Bin filler brushes
- Transfer brushes in general

There were four *E.coli* detections:

- Facility 1 on a wax brush under the wax applicator at the start of the shift.
- Facility 2 on repair tape on a spacer bar.
- Facility 5 on a transfer rubber – the same date (10/2) and location where environmental *Listeria* was detected (see above) – and one fruit sample at the start of shift after going over the brushbed.

These three facilities had the highest average aerobic colony counts (Figure 2).

### 4.3. Aerobic Bacteria

Aerobic colony counts (ACCs) provide a general indicator of adequate cleaning and sanitation (although not food safety because food borne human pathogens can be present at low counts and can provide some means to rank the packing facilities. Facility 6 was by far the best performing packing facility in this project. Facility 6 had aerobic colony counts 3 orders of magnitude lower at the start of shift and 2 orders of magnitude lower at the end of shift than the other five facilities – the ACCs at the end of the production shift at facility 6 were often lower than the ACCs at the start of the shift at other facilities. Their success demonstrates that it is possible to clean a packing line to very low counts, and reduce these by 2-3 log<sub>10</sub> values with COP steam cleaning and a multi-hurdle approach during a production shift.

Facilities 3 and 6 had the lowest average aerobic colony counts on the packing line (Figure 2), and also had the lowest aerobic colony counts on fruit (Figure 4). Facility 5 had high counts throughout the line and consequently the fruit from that facility had the highest counts. General comments regarding specific areas on packing lines are given below in Table 2.

**Table 2: Comments on cleaning and sanitation procedures for zones 1 and 2 areas on apple packing facilities.**

Area	General Comments
Soap and sanitizer brushes	Need attention during cleaning
Drying brushes	ATP swab first brushes; highest ACC there, decreasing down bed
Wax brushes	All CIP lines have high ACCs, especially under the wax applicator. ATP swab brushes under the wax applicator.
Oven rollers	Lower concern, but high residues indicate higher ACCs
Post-oven transfer brushes	Can have high loads, need more attention during cleaning and sanitation
Alignment brushes	Lower concern
Bin filler brushes	Some concern, need more attention during cleaning and sanitation
Transfer brushes	Some concern, need more attention during cleaning and sanitation
Other surfaces	Other surfaces, like fruit pushers, oven walls, etc. require attention during cleaning and sanitation in the worse performing packing facilities. Surfaces like tape, foam, cloth and rubber should ideally be removed from the line because they are potential harborage sites for food pathogens.

ACC, aerobic colony count; CIP, Clean in Place

### 4.4. Molds

The mold counts on the packing lines generally increased during the production shift and correlated with the aerobic colony counts. Facilities 3 and 6 having lower mold counts and facilities 1, 2, and 5 having higher loads (Figure 5 and Figure 6). This will vary by lot and storage duration, however, and requires longer term monitoring. Facility 1 did not have good mold control over the brushbed and consequently through the shift, with both mold and aerobic counts increasing over time on fruit (Figure 6). Yeast counts followed a similar trend to molds so data were not presented for brevity. Good cleaning and sanitation practices not only reduce food safety risks, but may improve returns by reducing rejections of packed fruit with an extended storage period – such as exports or in a high production season.

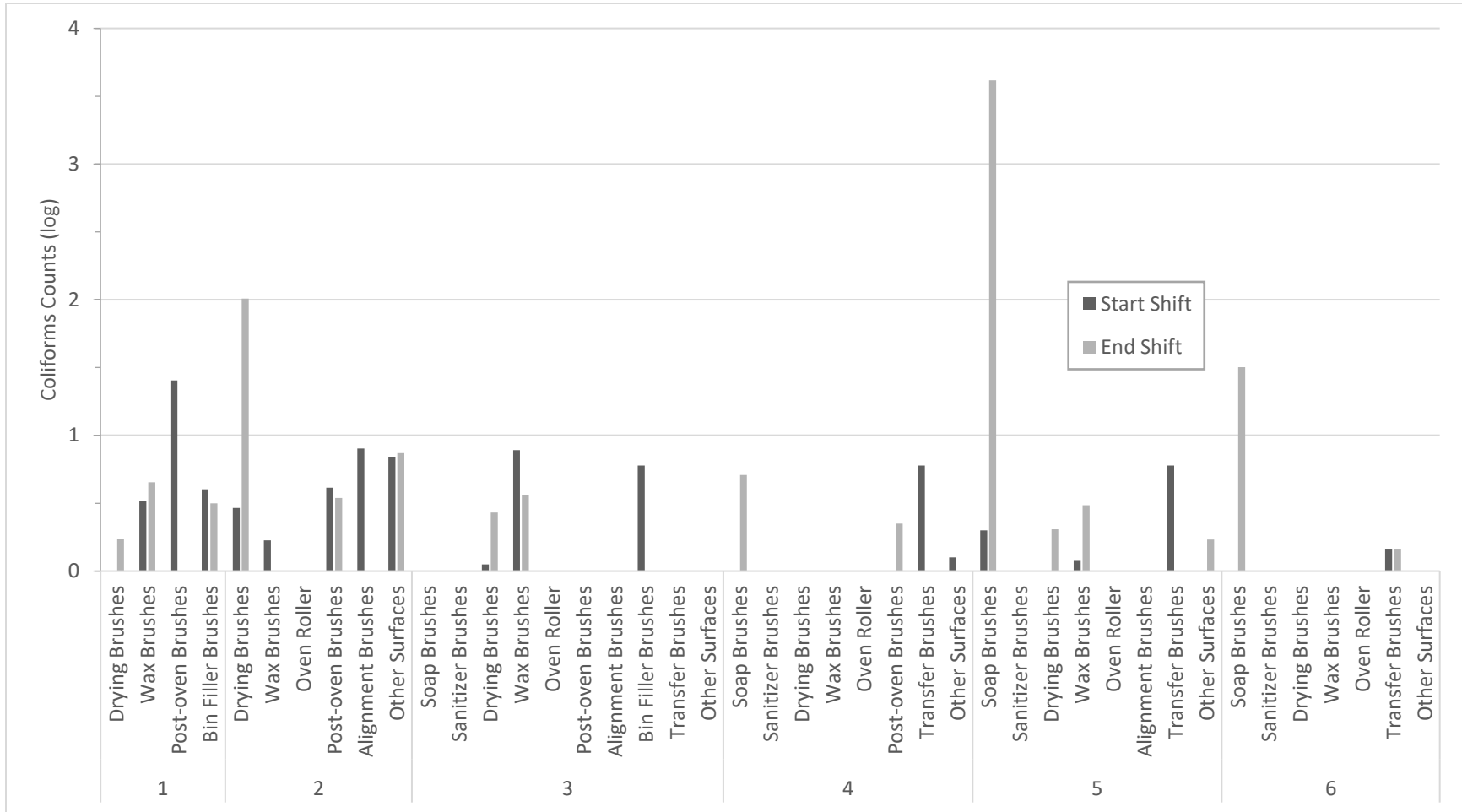
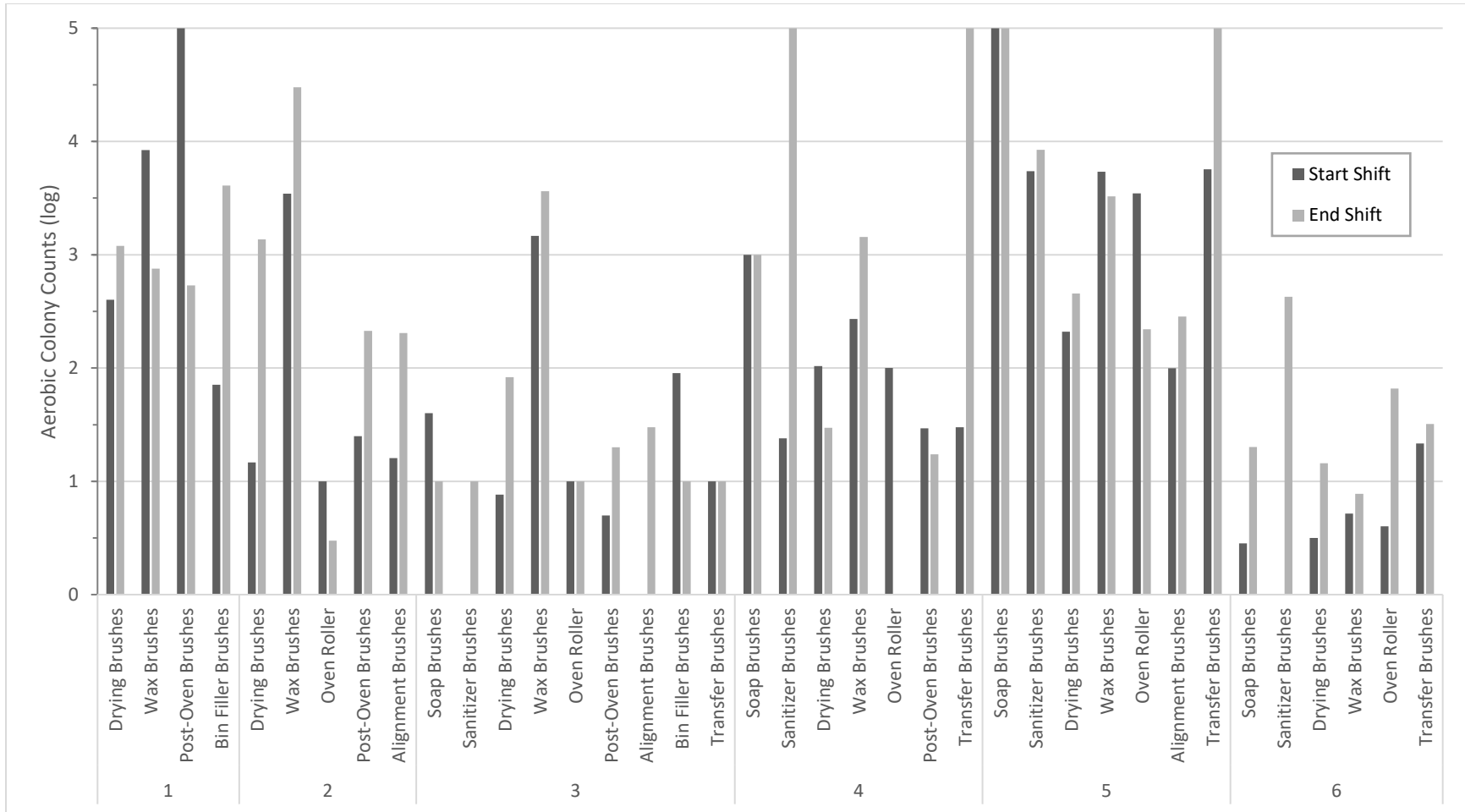
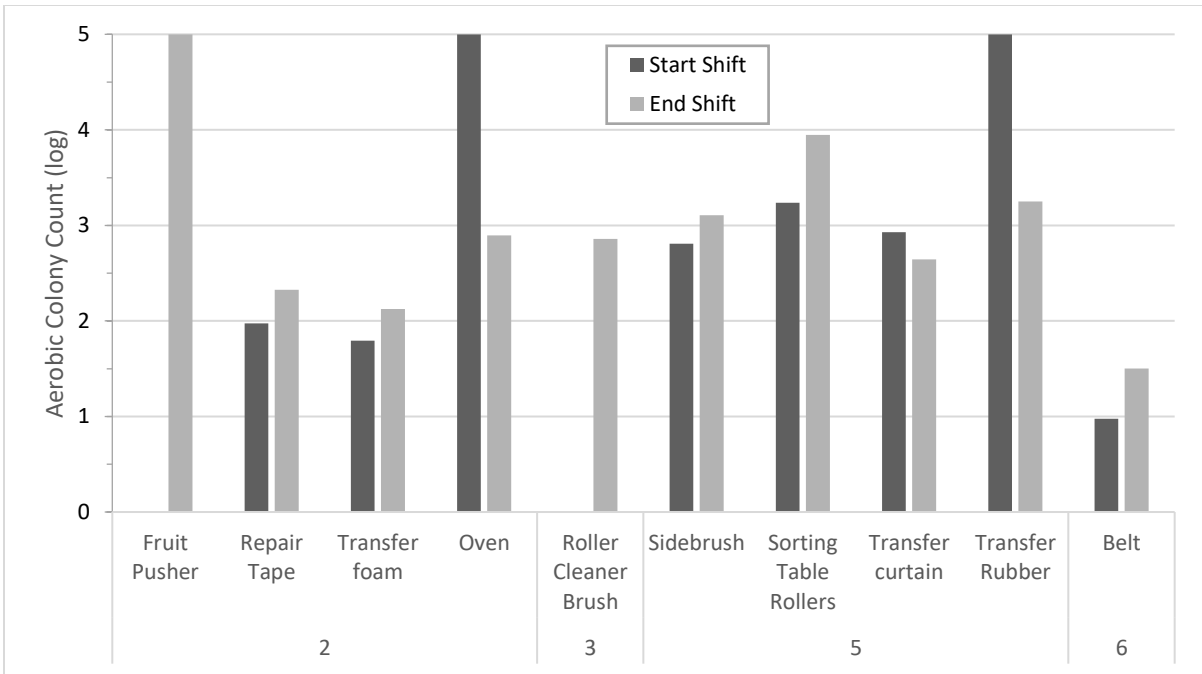


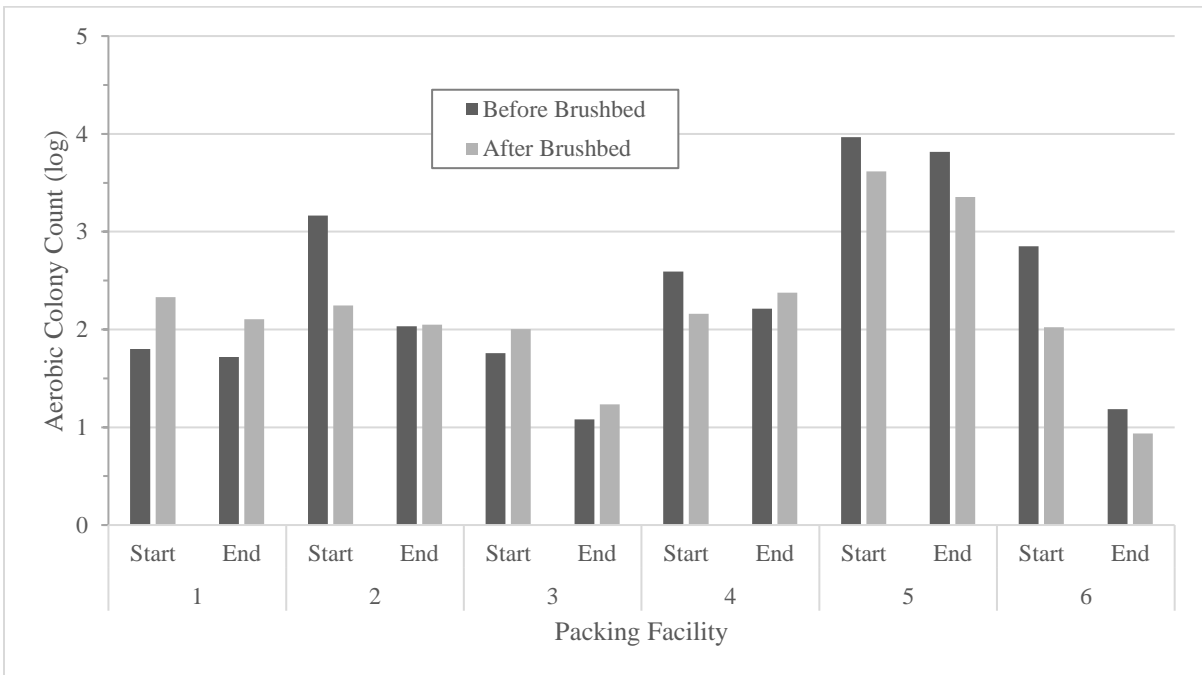
Figure 1: Coliform counts on the packing lines of six participating packing facilities.



**Figure 2: Aerobic colony counts on the packing lines of six participating packing facilities**



**Figure 3: Aerobic colony counts on selected packing line surfaces at four of the participating packing facilities.**



**Figure 4: Aerobic colony counts on apple fruit at the start and end of shift, sampled before and after the brushbeds of the six participating packing facilities.**

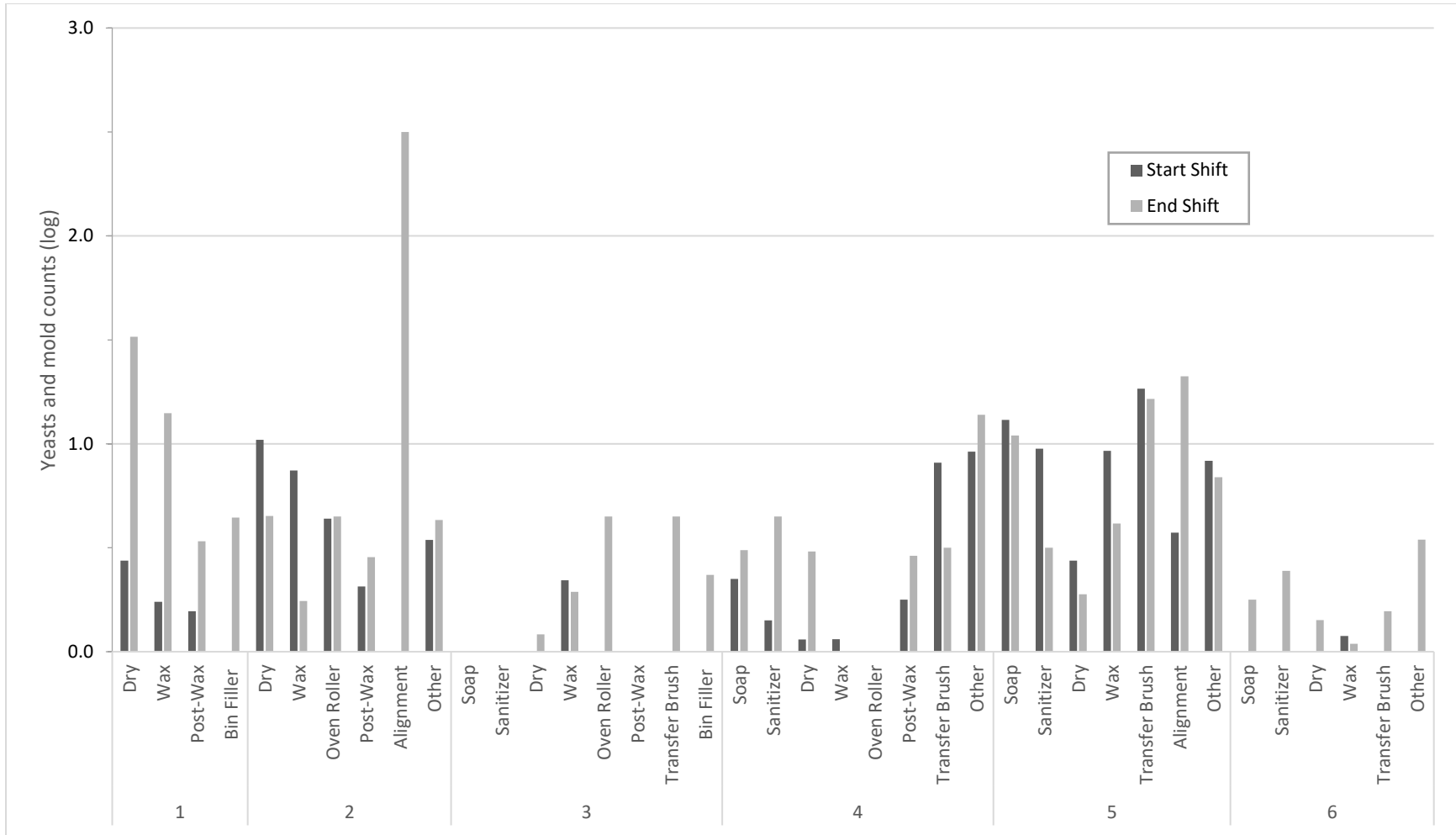
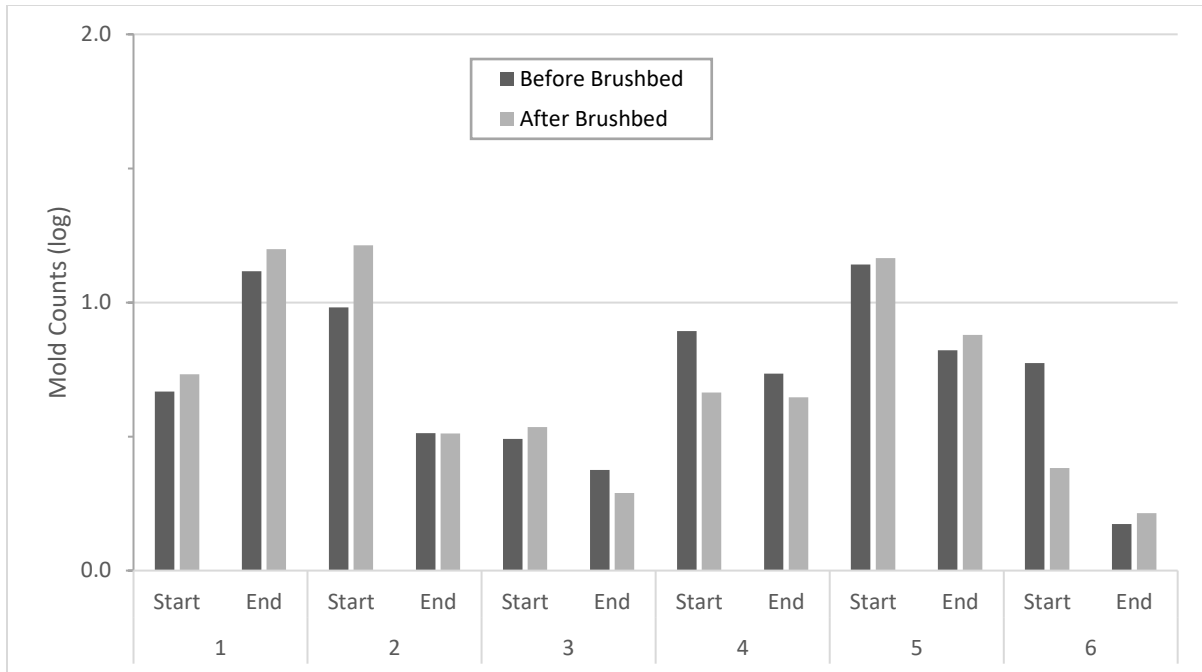


Figure 5: Mold counts on the brushes and other surfaces of packing lines of six participating packing facilities.





**Figure 6: Mold counts on fruit at the start and end of shift, taken before and after the brushbeds of the six participating packing facilities.**

## 5. Conclusion

Newer facilities generally had lower aerobic colony counts, but this was mostly caused by high microbial counts just on the wax brushes of older lines - attention needs to be paid to cleaning these brushes, and using ATP monitoring to determine when to replace these. That being said, newer facilities can have unacceptably high microbial counts, without daily attention to cleaning and sanitation. COP steam cleaning of brushes resulted in a significant reduction in microbial counts, but has been noted to reduce the life of brushes. The other five facilities did not have appreciable differences in their sanitation SOPs, so we believe that the differences are often in the execution of these SOPs. Some key points to improving hygiene levels in packing facility, and reducing food safety risk are: a motivated, properly equipped sanitation crew with attention to detail and sufficient time to clean and sanitize the packing facility, a validated hygiene monitoring system, an appropriate sanitizer monitoring system and protocol, and leadership from management to continually improve hygiene levels in a facility.

These results only provide a snap shot at each packing facility. To be effective, a food safety program requires daily attention, and long term planning for continual improvement. These assays, excluding the environmental Listeria test, can be done easily at a packing facility and the results used to improve cleaning and sanitation procedures at the facility.

## 6. Executive Summary

Aerobic colony counts (ACCs), coliforms and *E.coli*, environmental *Listeria*, and yeasts and molds samples were taken at six apple packing facilities in Yakima and Wenatchee between August and October 2017. These facilities were representative of the types of packing lines currently in Washington. The brushbed was swabbed before and after a production shift. Fruit samples were also taken at the same times, before and after going over the brushbed. Microbial tests were performed using 3M Petrifilm™ plates.

In general, **ACCs** at the start of production were lower in the three newest lines, but results show that it is possible to clean older facilities to levels comparable to those of newer lines. This may require extra attention to remove dirt and wax residues, and may require more frequent brush replacement but this should be considered against the risk and cost of a food safety recall. **Coliforms** were detected on all the packing lines, with detections associated with high ACCs. *E.coli* was sporadically detected at the three facilities with the highest ACCs. **Environmental *Listeria*** was only detected on one older line with high ACCs. **Yeasts and molds** also correlated with ACCs, suggesting that beyond food safety, cleaner lines may have reduced post-packing decay – particularly on fruit with an extended post-packing storage duration.

One packing facility stands out amongst the six, having aerobic colony counts (ACCs) 3.2 orders of magnitude lower than the average of the other five facilities. Brushes at this facility were cleaner at the end of the production shift than most facilities' brushes at the start of their production shift. This facility uses a multi-hurdle approach with multiple sanitizers during production and a clean out of place (COP) steam sanitation system for brushes. Five of the six (old and new) facilities used foaming chlorine cleaner and a quaternary ammonium compound or PAA sanitizer, so differences are not in these products but in the execution. In our opinion, this comes down to: a motivated, properly equipped sanitation crew with attention to detail and sufficient time to clean and sanitize the packing facility, a validated hygiene monitoring system, an appropriate sanitizer monitoring system and protocol, and leadership from management to continually improve hygiene levels in a facility. Monitoring will continue in 2018.