

Optimizing RFID Cage Census ~~Frequency~~

VOEN Analytics Conference 2018



Ethan Hildebrand¹, Jason Jorgenson¹, Steve Niemi¹, Rupesh Patel²

¹Office of Animal Resources, Harvard University, Cambridge MA

²Allentown, Inc., Allentown NJ

Monday, 29 January 2018

Optimizing RFID Cage Census

VOEN Analytics Conference 2018



Ethan Hildebrand¹, Jason Jorgenson¹, Steve Niemi¹, Rupesh Patel²

¹Office of Animal Resources, Harvard University, Cambridge MA

²Allentown, Inc., Allentown NJ

Monday, 29 January 2018

Our Animal Care Program

- Almost all mice (no large species)
- Ave daily census = 9,500 cages
- All sterilized (SPF/barrier) housing
- IVC microisolator caging, auto water, robotic cage wash
- 25 FTE's (20 = HUCTW members)
- Direct costs = \$3.4M/year (80% = labor expense)



Harvard FAS Cage Census

Cage Census = 94% of revenue

- “It’s all about the census!”

2006 – May 2016: Handcounts

- 1x/week (Wednesday)
- Counts written on paper, compiled monthly for billing
- No easy analytics

June 2016 – present: RFID Census

- WiCom Sensus, Allentown, Inc.



Harvard FAS RFID Census

45 populated rodent rooms

- a. Fixed RFID readers: 31 rooms (69%, ~8500 cages), automatic
- b. Handheld readers: 14 rooms (31%, ~1000 cages), manual



RFID tags embedded in cage cards



New RFID cage cards...

- From Vendors: Printed on demand
- Splits/weans: Preprinted, available in rooms



Decision Time – RFID Census Options

Possible RFID Census Strategies

1. Snapshot: single count represents census
2. Bracketed: starting scan and ending scan
3. Continuous: >2 counts

How frequently?

- Hourly, daily, weekly... etc.

Possible Billing Strategies

- A. Snapshot: no choice
 - single data point determines census
- B. Bracketed and Continuous: many options...
 - Charge for all novel scanned RFID tags?
 - Charge only if present for the entire day?
 - Charge if present for X% of day?, Etc...



Harvard RFID Census Rationale

Constraints

Compliance – All rooms must be treated the same

Equipment – 31% of rooms scanned by hand

Staffing – can accommodate 1x/day RFID census manual scans, M-F only

Decision (applies to all rooms)

M-F daily census

- Fixed reader rooms – automatic at 6am
- Handheld rooms – first thing, typically completed by 7:30 AM

Sat. & Sun. – carry forward of Fri. census



Defining – “Optimized”

Is there an optimum time to capture census?

Based on:

1. Data (Time Optimization)
2. “Fairness” to customers
3. Operations



Time Optimization – Experiment

Hypothesis:

We can identify census time points with material effects on total revenue.

Experimental Design:

- DEV application
- All rooms with fixed RFID readers (n=31)
- RFID census scan at 7 time points each day
(5am, 7am, 9am, 11am, 1pm, 3pm, 5pm)
- Collect data for 3 weeks
- Output = list of every RFID tag (cage) and associated room at each day/time



Time Optimization – Raw Data

Each day/time output as a list of RFID tags

~9 Million data points

	A	B	C
1	RFID	Last Scan Date Time	Room
2	AAAAAC0010016091200000185	12/22/17 5:00 AM	328.11
3	AAAAAC0010016110900000207	12/22/17 5:00 AM	328.11
4	AAAAAC0010017022800000239	12/22/17 5:00 AM	328.11
5	AAAAAC0010017050100000170	12/22/17 5:00 AM	328.11
6	AAAAAC0010017050100000189	12/22/17 5:00 AM	328.11
7	AAAAAC0010017061300000140	12/22/17 5:00 AM	328.11
8	AAAAAC0010017061300000173	12/22/17 5:00 AM	328.11
9	AAAAAC0010017061300000200	12/22/17 5:00 AM	328.11
10	AAAAAC0010017053000000052	12/22/17 5:00 AM	328.11
11	AAAAAC0010017062100000066	12/22/17 5:00 AM	328.11
12	AAAAAC0010017062100000069	12/22/17 5:00 AM	328.11
13	AAAAAC0010017062100000082	12/22/17 5:00 AM	328.11
14	AAAAAC0010017062100000088	12/22/17 5:00 AM	328.11
15	AAAAAC0010017062100000096	12/22/17 5:00 AM	328.11
16	AAAAAC0010017062100000099	12/22/17 5:00 AM	328.11
17	AAAAAC0010017062100000113	12/22/17 5:00 AM	328.11
18	AAAAAC0010017062100000115	12/22/17 5:00 AM	328.11
19	AAAAAC0010017062100000134	12/22/17 5:00 AM	328.11
20	AAAAAC0010017083000000770	12/22/17 5:00 AM	328.11
21	AAAAAC0010017083000000801	12/22/17 5:00 AM	328.11
22	AAAAAC0010017083000000807	12/22/17 5:00 AM	328.11
23	AAAAAC0010017083000000808	12/22/17 5:00 AM	328.11
24	AAAAAC0010017083000000823	12/22/17 5:00 AM	328.11
25	AAAAAC00100170931900000347	12/22/17 5:00 AM	328.11
26	AAAAAC0010017083000000835	12/22/17 5:00 AM	328.11
27	AAAAAC0010017083000000836	12/22/17 5:00 AM	328.11
28	AAAAAC0010017083000000857	12/22/17 5:00 AM	328.11
29	AAAAAC0010017083000000866	12/22/17 5:00 AM	328.11
30	AAAAAC0010017081800001136	12/22/17 5:00 AM	328.11
31	AAAAAC0010017071200000001	12/22/17 5:00 AM	328.11
32	AAAAAC0010016101100000125	12/22/17 5:00 AM	328.11
33	AAAAAC0010016101100000126	12/22/17 5:00 AM	328.11
34	AAAAAC0010016101100000129	12/22/17 5:00 AM	328.11
35	AAAAAC0010017021500000203	12/22/17 5:00 AM	328.11
36	AAAAAC0010017022800000239	12/22/17 5:00 AM	328.11
37	AAAAAC0010017022800000281	12/22/17 5:00 AM	328.11
38	AAAAAC0010017050100000191	12/22/17 5:00 AM	328.11
39	AAAAAC0010017053000000061	12/22/17 5:00 AM	328.11
40	AAAAAC0010017062100000045	12/22/17 5:00 AM	328.11
41	AAAAAC0010017062100000075	12/22/17 5:00 AM	328.11
42	AAAAAC0010017062100000087	12/22/17 5:00 AM	328.11
43	AAAAAC0010017062100000103	12/22/17 5:00 AM	328.11
44	AAAAAC0010017062100000135	12/22/17 5:00 AM	328.11
45	AAAAAC0010017062100000137	12/22/17 5:00 AM	328.11
46	AAAAAC0010017062100000140	12/22/17 5:00 AM	328.11
47	AAAAAC0010017061300000141	12/22/17 5:00 AM	328.11
48	AAAAAC0010017061300000169	12/22/17 5:00 AM	328.11
49	AAAAAC0010017061300000202	12/22/17 5:00 AM	328.11
50	AAAAAC0010017061300000204	12/22/17 5:00 AM	328.11
51	AAAAAC0010017083000000775	12/22/17 5:00 AM	328.11
52	AAAAAC0010017083000000781	12/22/17 5:00 AM	328.11
53	AAAAAC0010017083000000782	12/22/17 5:00 AM	328.11
54	AAAAAC0010017083000000812	12/22/17 5:00 AM	328.11
55	AAAAAC0010017083000000814	12/22/17 5:00 AM	328.11
56	AAAAAC0010017083000000818	12/22/17 5:00 AM	328.11
57	AAAAAC0010017083000000826	12/22/17 5:00 AM	328.11
58	AAAAAC0010017083000000829	12/22/17 5:00 AM	328.11
59	AAAAAC00100170931900000346	12/22/17 5:00 AM	328.11
60	AAAAAC00100170931900000372	12/22/17 5:00 AM	328.11
61	AAAAAC0010017100500000131	12/22/17 5:00 AM	328.11
62	AAAAAC0010017083000000830	12/22/17 5:00 AM	328.11

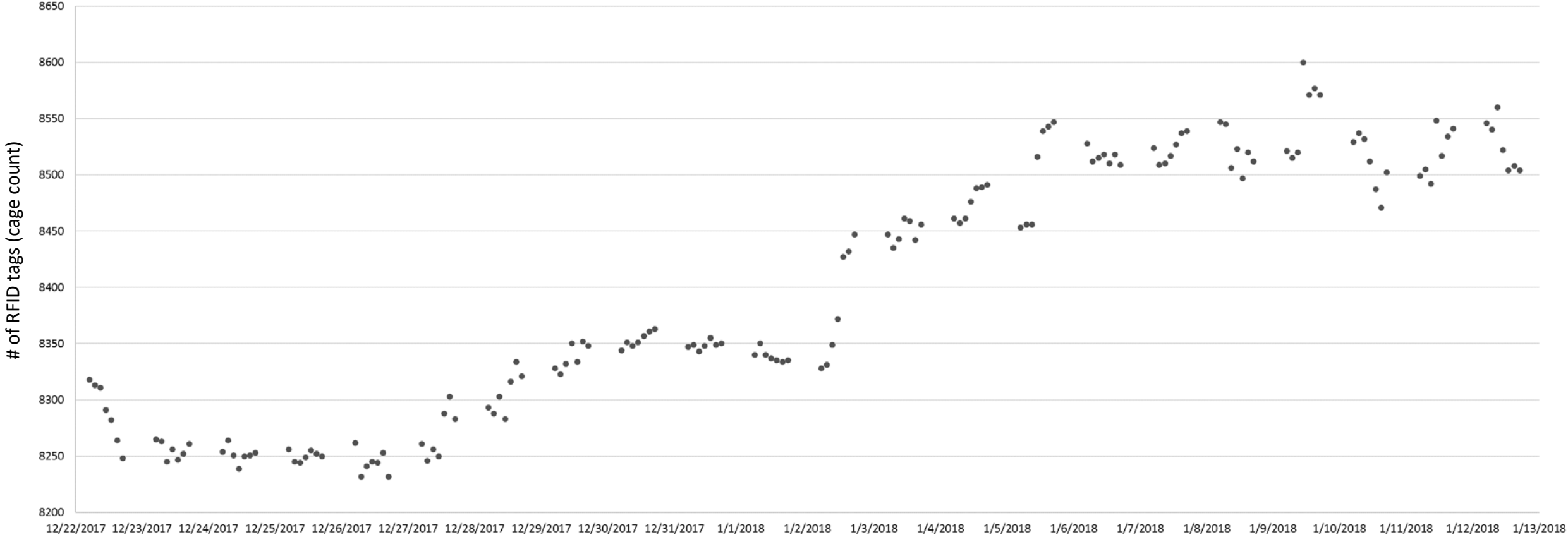
Pivot table to compile data by room



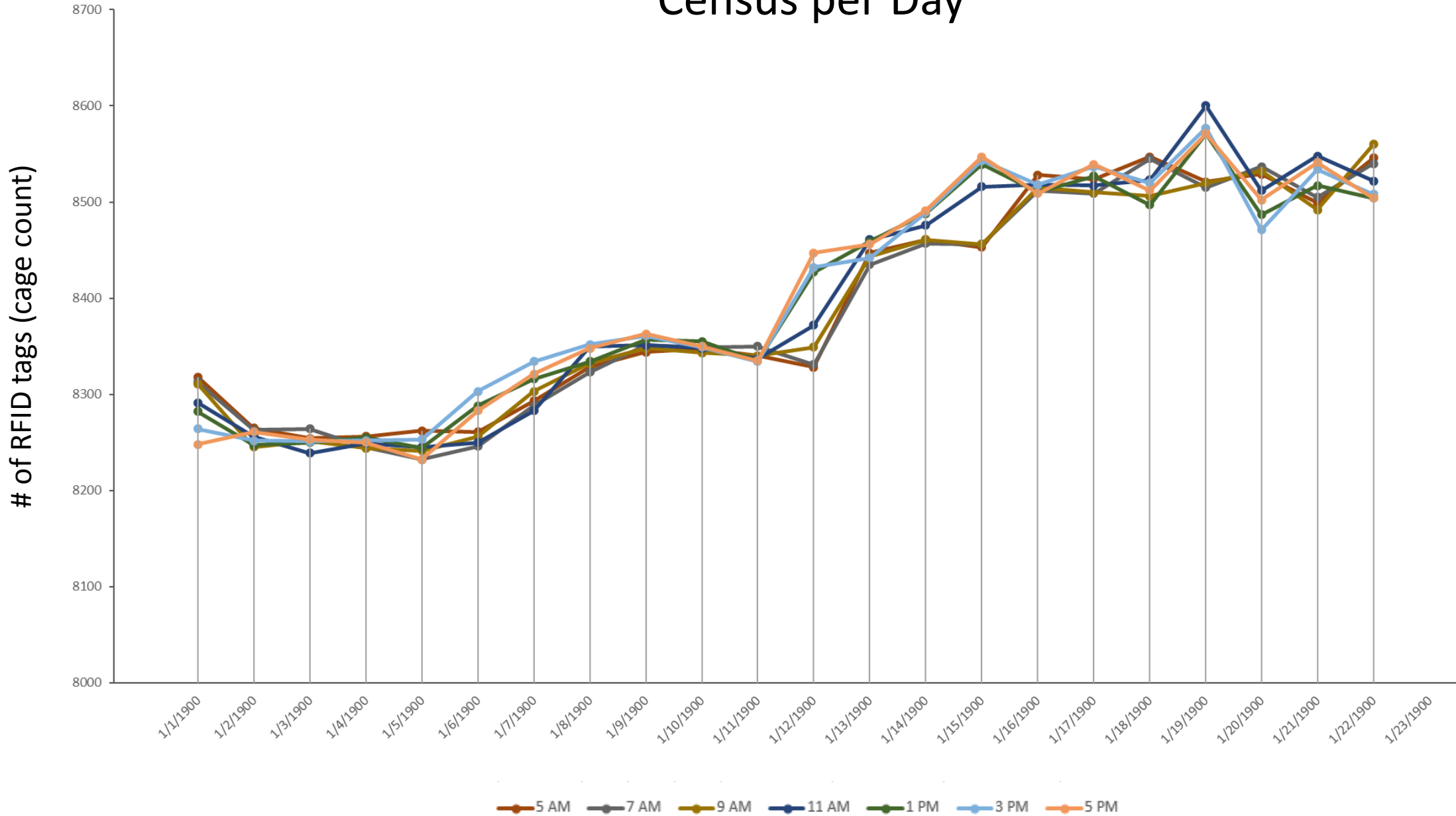
Room	5 AM	7 AM	9 AM	11 AM	1 PM	3 PM	5 PM
328.11	150	150	149	151	150	150	147
328.13	51	43	50	47	46	43	49
328.15	158	166	161	162	155	154	149
328.30	32	32	32	31	31	31	31
A1102	58	58	57	58	58	57	58
A1111	287	286	290	269	254	253	253
A1114	263	266	253	266	270	271	267
A1202	268	268	270	273	269	273	271
A1209	397	395	408	408	404	404	408
A1214	385	376	381	384	387	383	387
A1303	382	381	379	379	383	379	380
A1305	319	321	307	313	313	316	311
A1306	269	272	269	275	267	270	267
A1309	252	260	261	241	256	259	254
A1403	374	373	374	374	373	373	369
A1404	19	18	19	18	19	18	20
A1405	414	411	416	408	411	406	405
A1406	327	329	324	327	328	328	326
A1409	108	108	108	108	108	108	108
A1410	209	208	209	209	209	205	205
A1501	372	370	372	372	369	370	372
A1508	119	122	121	120	124	121	130
A1601	101	101	101	101	101	101	101
A1603	339	339	337	340	343	343	342
A1604	503	505	513	508	511	514	514
A1607	325	322	322	324	321	321	319
A1608	370	368	368	365	371	367	368
A1702	337	336	337	333	335	335	333
A1703	495	492	486	493	490	488	488
A1707	236	238	238	239	232	225	223
A1708	200	200	200	205	204	208	202
Grand Total	8318	8313	8311	8291	8282	8264	8248



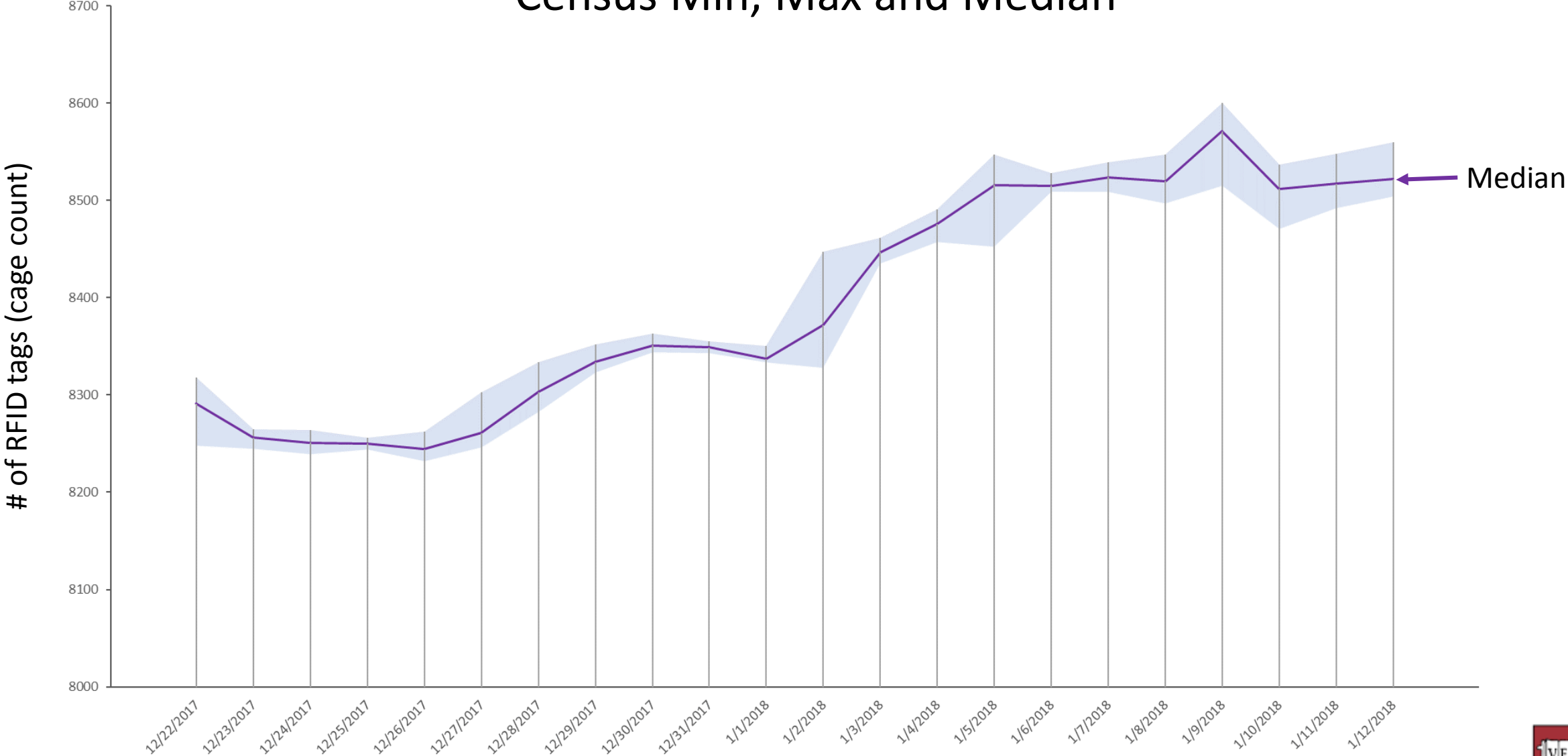
Total RFID Census by Day/Time



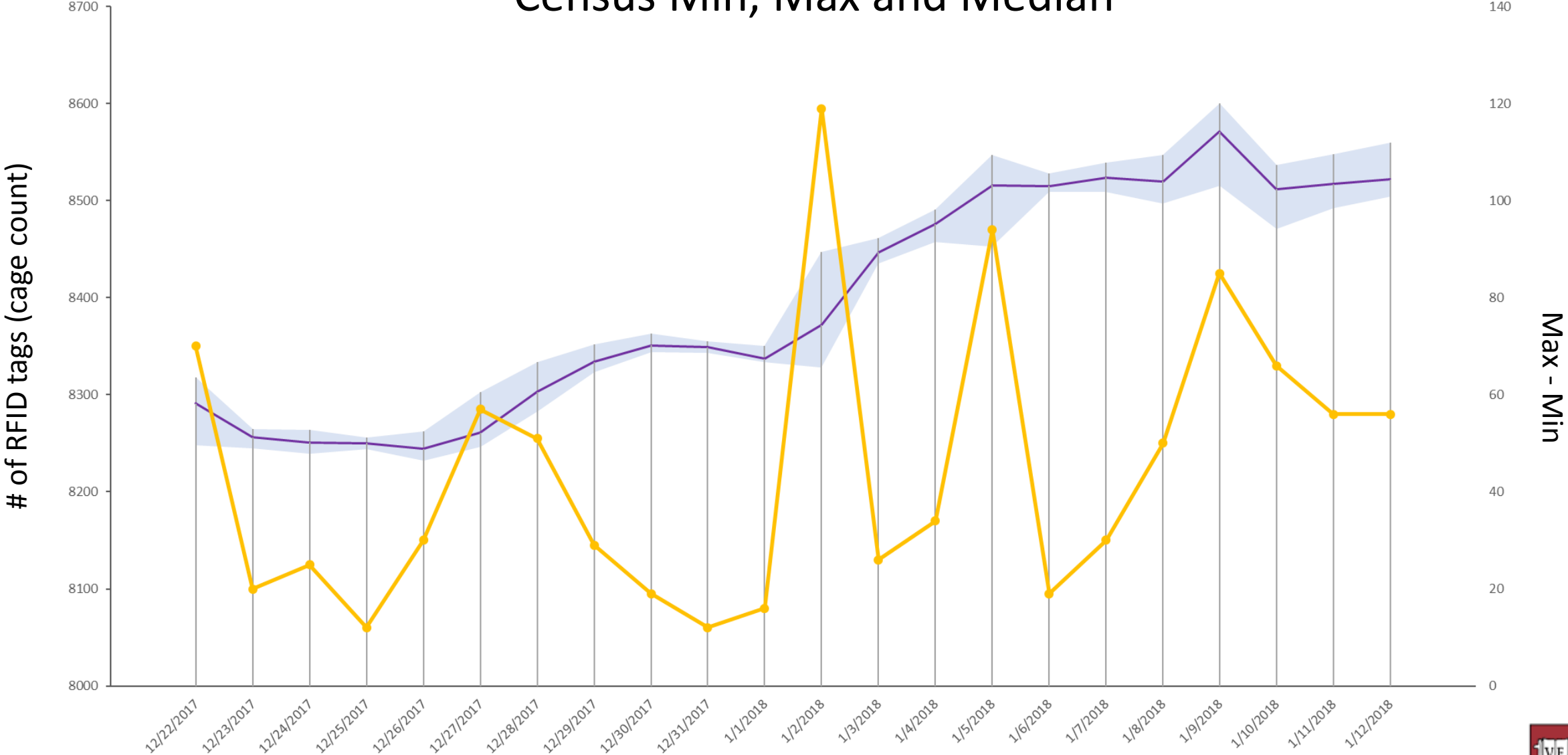
Census per Day



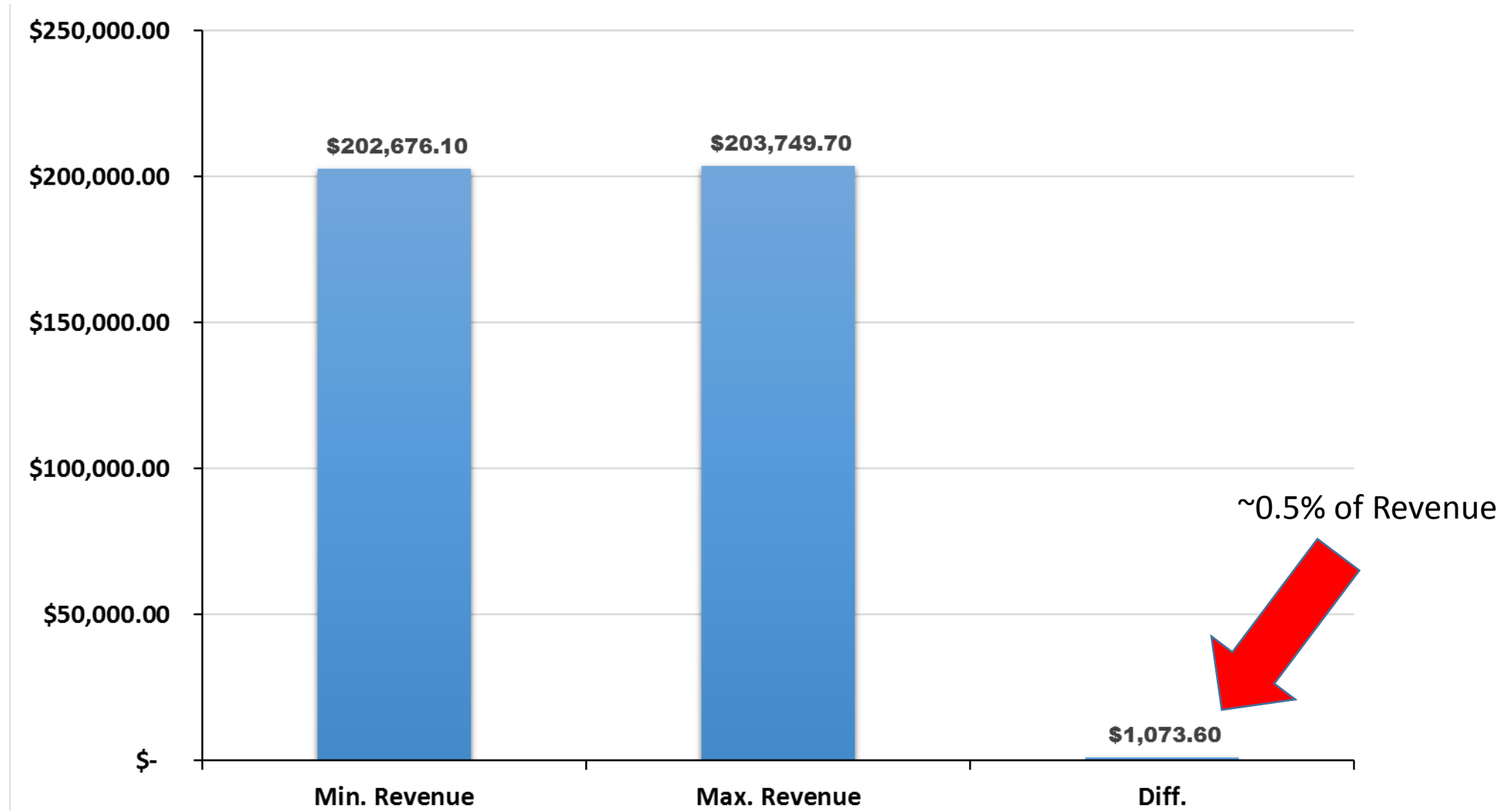
Census Min, Max and Median



Census Min, Max and Median



Revenue Comparison



Time Optimization – Results

Observations

1. Census does change over the course of a day
2. No material effect on revenue (~0.5%)

Conclusions

Therefore, RFID census any time between 5 AM and 5 PM is OK
Or, time optimization fruitless



“Fairness” Optimization

Current State

All rooms treated the same

M-F daily census

- Fixed reader rooms – automatic at 6am
- Handheld rooms – first thing, typically completed by 7:30 AM

Sat. & Sun. – carry forward of Fri. census

All rooms treated the same

= each investigator’s cages counted the same way (fair)



“Fairness” Optimization - continued

Cages in rooms at 6 AM billed for the entire day

Researcher:

So, if I remove my cage at 8 AM I get billed for the whole day?

OAR:

Yes, but new cages arrive after 6 AM

receiving completed ~12 PM

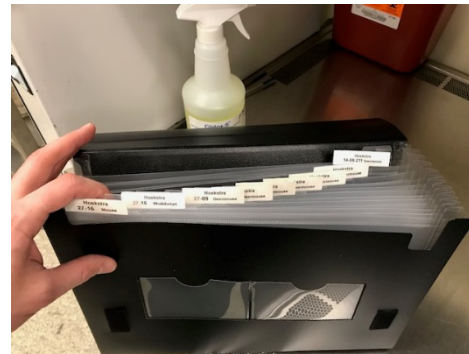
most room activity occurs after 6 AM (Splits/Weans)

Result – day 1 is free, last day counts (fair)



Operations Optimization

1. RFID signal blocked by water and metal
 - people = water
 - equipment = metal
 - Best to take census before people/equipment enter the rooms
2. Pre-printed cards could be scanned (scan = \$) if not contained
 - Best to take census before people enter the rooms to work



Operations Optimization - continued

3. Time to receive and respond to RFID census reports
 - RFID reader error report – list of reader malfunctions (6:30 AM)
 - Daily census report – list of room census (9 AM)
 - Opportunity for staff to report observations
 - 6 hours to identify, diagnose, and correct errors

4. Husbandry staff 1st task – flood check in all rooms
 - Good opportunity for manual RFID Census scan (31% of rooms)



Optimization Summery

1. Data (Time Optimization)
 - does not suggest any one optimal census time
2. “Fairness”
 - all rooms/cages treated the same
 - day 1 is free, last day counts (balance of charges)
3. Operations
 - Best before people enter rooms
 - Close to work hours to identify and correct problems (no overtime)
 - Convenient time for staff to perform manual RFID census (31% of rooms)



Result

Current state is optimal

- All rooms treated the same
- M-F daily census
 - Fixed reader rooms – automatic at 6am
 - Handheld rooms – first thing, typically completed by 7:30 AM
- Sat. & Sun. – carry forward of Fri. census

No change needed



VOEN Analytics Conference 2018
Impact Summary



Title: Optimizing RFID Cage Census

Problem and analysis method: When is the optimal time to perform RFID census? Consider census trends throughout workday, "fairness" to customers, and daily operations to determine the optimal time to perform RFID census.

Summary: An analysis of the daily census trends showed no material difference in per diem-based revenue at any RFID census time point. Current state is fair to customers and equally performed across all rooms. Daily operations point to optimal RFID census scan at 6 AM (current state).

Impact of the analytics study

Decisions made/Actions Taken: We verified that our current RFID census process (6 AM census, M-F) is optimal based on census data, fairness to customers, and operations; no change needed.

Calculated or actual Improvements:

Animal Welfare NA

Resource use current state is optimal

Cost avoidance current state is optimal