Hawaii Department of Health
Office of Solid Waste Management
RECYCLING SEGREGATED RATE SAMPLING PROJECT

Presented by:
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Agenda

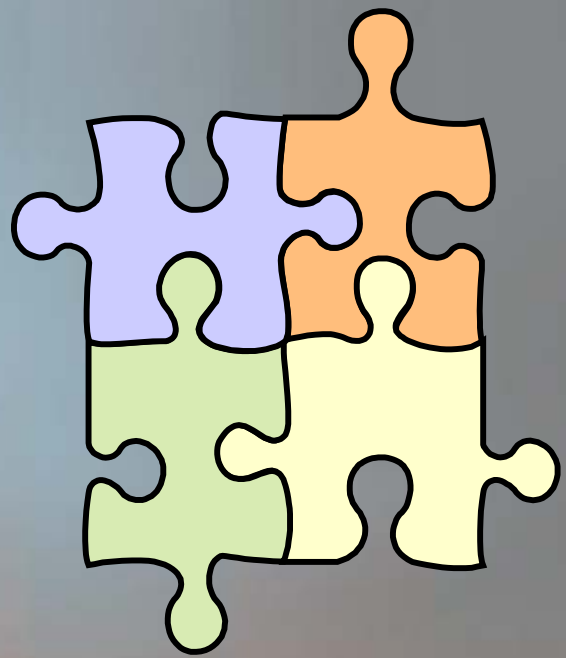
- Introductions
- Statistical Sampling
  (the math behind the magic)
- Sampling Procedures
- Data Entry / Recordkeeping
- Data Backup Procedures
- Selected Sites & Scheduling
- Data Analysis
- Q&A

Introductions

- Capital Pathways, LLC
  - Scott Dosick, President
    - Deputy Chief of Recycling
      CA Department of Conservation
      1999 – 2005
  - My-Ai Bui, Senior Statistician
    - Recycling Specialist / Statistician
    - CA Department of Conservation
    - 2000 – 2004

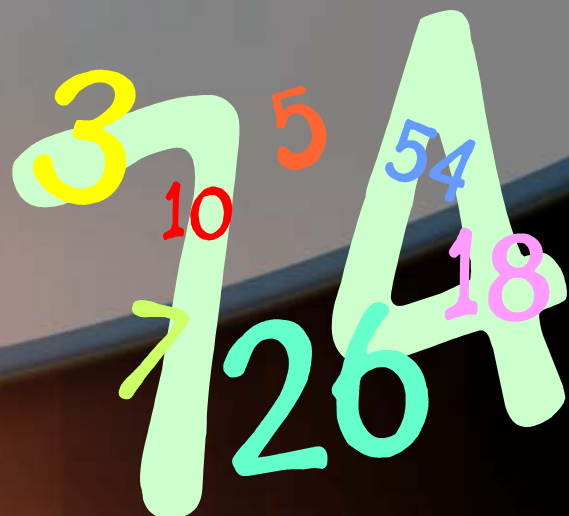
Goals & Objectives

- Gain a mutual understanding of
  - Background
  - Statistics
  - Process
  - Results



Statistical Sampling

- Terms
  - Confidence Level
  - Margin of Error
- Basis and explanation for sample size
- Importance of consistency & accuracy (garbage in / garbage out)
- Questions?



Statistical Sampling

- 95% confidence level is used for all material types
- Margins of error
  - Aluminum: +/- .75%
  - Glass: +/- 1%
  - PET: +/- 2%
- Based on DOH's previous study, the variance of the segregated rate can be described as: $\tilde{S}_i^2 \approx s_{di}^2 = \sum_{j=1}^{n_i} \frac{(y_j - Rx_j)^2}{n_i - 1}$

The Math Behind the Magic

Definitions and Formulae

Let the size of the population from *i*th county be denoted N_i.

Let the size of the sample from *i*th county be denoted n_i.

Let the sample variance from *i*th county be denoted $S_{d_i}^{\ 2}$

Let $(x_{ji,}, y_{ji})$ represent the container-refund values pair for the *j*th participant sampled from the *i*th county.

$$\hat{r}_i = \frac{\sum_{j=1}^{n_i} y_{ji}}{\sum_{j=1}^{n_i} x_{ji}}$$

The sample size formula for estimating segregated rate study with an error rate of at most *D* and a confidence level of (1- α)100% is given by:

$$n = \frac{(\sum n_i S_{d_i})^2}{D + \sum n_i S_{d_i}^2}; \text{ where } \quad S_{d_i}^{\ 2} = \frac{\sum_{j=1}^{N_i} (y_{ji} - r_i x_{ji})^2}{n_i - 1}$$

Statistical Sampling (cont)

- Total Containers to be Sampled
  - Aluminum: 7,822
  - Glass: 3,104
  - PET: 6,768
- Containers by island/material

County	# of Site	Aluminum	Glass	PET	HDPE	Bi-Metal	Total
Big Island	3	345	125	214	40	40	764
Kauai	1	159	86	104	40	40	429
Maui	4	291	88	257	40	40	716
Oahu	17	321	135	294	40	40	830

Sample Sizes

Big Island:

Container	Aluminum	Bimetal	Glass	Plastic
Total	345	40	125	214

Kauai:

Container	Aluminum	Bimetal*	Glass	Plastic
Total	159	40	86	349

Maui:

Container	Aluminum	Bimetal*	Glass	Plastic
Total	291	40	88	257

Oahu:

Container	Aluminum	Bimetal*	Glass	Plastic
Total	300	40	135	294

* The number of containers sampled for bi-metal was based on actual counts obtained at each site.

Sampling Procedures

- Material type
- Class (Size)
  1. <12 oz
  2. 12 oz
  3. 12 oz to <24 oz
  4. >=24 oz
- Analyzing Survey Samples
  - Make sure that the survey sample contains only those containers that the program (i.e. RC/RVM or CP) has chosen to be surveyed.
  - A visual “grid” will be made on the material and the sample will be collected from random grid sectors.
  - Randomly sample from DBC loads of whole and unbroken containers for each material type
  - Once the sample size has been collected and prepared. Complete the sample analysis for one material type before another.


TECATE

Random Consumer Loads

Sampling Procedures II

- Sample Analysis
  - Place the scale on a solid, flat surface and make sure the scale is centered.
  - Zero the bucket
  - Randomly select containers from the survey sample, remove contaminants and count unbroken containers as they are placed into the zeroed bucket
  - Record the total bucket quantity
  - Record the total bucket weight
  - Remove the containers from the bucket and sort by class categories.
  - Note: Glass is sorted by color first and then each color is further broken down by class category.

Sampling Procedures III

- Count the containers in each class category and confirm the total bucket quantity
- (a) Record the quantity of containers by class
- (b) Place the containers from that class category into the zeroed bucket and record dirty weight
- (c) Zero the bucket
- Repeat steps (a) to (c) for each class.
- QA / QC – make sure you get enough containers by material before you leave each site!

Consistency & Accuracy

- Random selection
- Material isolated
- Sorted by class (size)
- Scale
  - Balanced
  - Centered
  - Zeroed
- Material weighed
- Containers counted
- Abnormalities re-checked
- Data recorded

Data Entry / Recordkeeping

Date		Time in		Site #	
Team Members		Time out		Site name	
				County	

Detail

Bkt #	Class	Container Count	Container Weight

Summary

Bkt #	Container Count	Container Weight
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Difference

Bkt #	Container Count	Container Weight
1	-	-
2	-	-
3	-	-
4	-	-
5	-	-
6	-	-
7	-	-
8	-	-
9	-	-
10	-	-
11	-	-
12	-	-
13	-	-
14	-	-
15	-	-
16	-	-
17	-	-
18	-	-
19	-	-
20	-	-

Data Backup Procedures

- USB Thumb drive
- CD-Rom
- Email
- Server
- End of the day… DOH and CP team each have complete, up to date copies of all survey data.

Randomly Selected Sites & Scheduling

County	RC/RVM Location
Hawaii	Waimea Convenience Center
Hawaii	Keaau Convenience Center
Hawaii	Puako Convenience Center
Kauai	Kanoa St.
Maui	Pauwela Road and Hana Hwy
Maui	Keawe St. and Oil Rd
Maui	2000 Mokulele Hwy
Maui	310 Kaahumanu Ave.
Oahu	2424 S. Beretania St. - Moiliili
Oahu	94-640 Kupuohi St. – Kunia Park & Ride
Oahu	2295 N. King St. -
Oahu	41-853 Kalanianaole Hwy.
Oahu	204 Sand Island Access Road
Oahu	Bldg. 1715, Kuntz Avenue
Oahu	87-2070 Farrington Hwy
Oahu	207 Puuhale Road
Oahu	46-047 Kamehameha Hwy.
Oahu	95-1249 Meheula Pkwy
Oahu	91-919 Ft. Weaver Rd.
Oahu	1090 Keolu Drive, Suite C-7
Oahu	300 Keahole St.
Oahu	501 Kealahou St.
Oahu	1001 California Ave.
Oahu	86-120 Farrington Hwy
Oahu	95-1101 Ukuwai St.

After all that math...

Rate Calculations

Number of Segregated Containers Per Pound (CPP)

$$\text{CPP} = \frac{\text{Number of DBC containers}}{\text{Total weight (lbs) of DBC containers}}$$

Results

- Based on the data in Attachment 1, “2007 Proposed Rates”, the segregated containers per pound rates found during this study are:
  - ***Aluminum: 30.5***
  - ***Glass: 2.2***
  - ***Plastic: 17.5***
  - ***Bi-metal: 6.5****
    - *note: The rate for bi-metal was based on actual counts and not on the actual sample size proposed for this study due to the lack of available bi-metal containers at the sites.

Class Size Data

- The average number of containers per pound did not change much from 2005 to 2007. However, the class size data showed some interesting information.
- The data shows that nearly 90% of all aluminum and glass containers redeemed are 12 ounce containers.
- Over 60% of the plastic bottles redeemed are 17 ounces or less.
- DOH decided to test rates based on container size to help consumers get back more accurate refunds.

Aluminum

Class	Cont. Count	% Tot Count	Cont. Weigh	% Tot Weigh	CPP
1	467	5.99%	13.59	5.33%	34.3635
2	6879	88.25%	217.95	85.54%	31.5626
3	319	4.09%	15.67	6.15%	20.3574
4	130	1.67%	7.58	2.98%	17.1504

Glass

Class	Cont. Count	% Tot Count	Cont. Weigh	% Tot Weigh	CPP
1	160	5.15%	77.49	5.46%	2.0648
2	2766	89.05%	1193.44	84.15%	2.3177
3	124	3.99%	87.87	6.20%	1.4112
4	56	1.80%	59.37	4.19%	0.9432

Plastics

Class	Cont. Count	% Tot Count	Cont. Weigh	% Tot Weigh	CPP
1	4088	61.40%	180.43	47.54%	22.6570
2	2200	33.04%	158.04	41.64%	13.9205
3	370	5.56%	41.03	10.81%	9.0178

DOH 2007 Segregated Rates

- DOH decided to use class size data to determine the following segregated containers per pound rates:
  - ***Aluminum: 31.6***
  - ***Glass: 2.3***
  - ***Plastic: 17.5 (mixed); 22.7 (small)***
  - ***Bi-metal: 8****
    - *note: No adjustment was made to the bi-metal rate because the study did not obtain the required sample size for this study due to the lack of available bi-metal containers at the sites.