Agricultural Survey Quarterly Meeting

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Agenda

- Survey background
- Overview of H-2A program
- Employer estimation
- Moving forward
Survey background

**What:**
- Wage rates and employment practices for agricultural worksites in Washington state

**Why:**
- U.S. Department of Labor (USDOL) requires survey every year for occupations and activities that involve temporary foreign workers
- USDOL uses survey results to establish wage rates and employment standards for agricultural employment contracts
Survey background

- **Who:**
  - Agricultural business under certain industry codes (NAICS)
  - Agricultural workers involved in apple and cherry harvesting

- **How:**
  - Survey development and administration
  - Data collected is aggregated and analyzed by ESD
  - Results provided on Employment & Training Administration (ETA) 232 forms
Overview of H-2A program

- Regulated by USDOL
- Used when there is a perceived shortage of domestic workers
- Employment is seasonal or temporary
- Employment of H-2A worker must not negatively impact wages and employment practices for similarly employed domestic workers
Employer estimation

- ESD requirements
- Caveats of estimation
- Estimation method
  - Method overview
  - Method assumptions
  - Analytical steps
- Results of application
  - Industry estimation
  - Crop estimation
  - Crop variety estimation
Employer estimation: ESD requirements

- USDOL/ETA form 232 requires:
  - Total number of employers contacted during the survey
  - Total number of respondents
  - Total number of U.S. workers reported by employers
  - Estimated number of U.S. workers
  - Estimated number of employers
    - Estimated number of crop variety growers
Employer estimation: caveats of estimation

- ESD administrative databases are limited:
  - Unemployment Insurance covers employers by NAICS and worksite location
    - Recorded by NAICS industry, not by crop or crop-variety
    - Single worksites can produce multiple crops and crop varieties
  - Reporting lag
  - Administrative databases do not tell us who qualifies for the survey
Employer estimation: method overview

- Classical capture-recapture estimators:
  - Classical experiment is to study the demographic characteristics of an animal population and determine the population size
  - Animals are captured, marked with a tag and released back into the population
    - The operation gets repeated several times
  - Each animal is associated with a capture history
    - Capture histories indicate a “catch” or a “miss” by a binary vector (1 or 0)

- General form of a population size estimator:
  - \( \hat{N} = n + \mu_0 \)
    - \( n \), is the number of units caught at least once
    - \( \mu_0 \), is the estimated number of units missed
    - \( \hat{N} \), is the estimated population size
History of capture-recapture and applications:

- Originally developed in the field of wildlife management (Petersen, 1896)
  - Petersen estimator
- Gained popularity with a treatment by Chapman (Chapman, 1951) in the field of ecology
- Log-linear treatment of capture-recapture estimators was later applied by Fienberg and Cormack (Fienberg, 1972; Cormack, 1989) to deal with heterogeneity of individual behaviors, which can bias estimators of abundance
- Has been further applied to fields such as: epidemiology, the evaluation of census undercount and software testing (International Working Group for Disease Monitoring and Forecasting, 1995 a,b; Darroch, Fienberg, Glonek & Junker 1993; Wohlin, Runeson & Brantestam 1995; Ebrahimi 1997; Briand, El Emam, Freimut & Leiterberger, 2000)
Employer estimation: method overview continued...

- Log-linear models for capture recapture:
  1) Determine the probability of a unit to experience a capture history
     - Example: Determine the likelihood of a crop-variety firm responding to the surveys
  2) From understanding the probability of capture, the expected number of units having a capture history can be determined
  3) The expected number of units having a capture history then is re-expressed as a log-linear model
     - Expression as a log-linear model aids in reducing inherent bias from the data and allows the fitting of a regression model to estimate abundance
  4) Fit a log-linear model
     - Poisson regression, deals with count data
     - Helps us identify bias, correct any bias found and produce a stable estimate
     - Enables the estimation of firms missed during the search occasions
  5) Abundance estimation
     - Produces final abundance estimate
     - Uses the number found at least once and the estimated number missed
Employer estimation: method overview continued…

- Base types of general linear models:
  - $M_0$: all capture occasions are independent with a common probability of being caught
  - $M_t$: each capture occasion has its own capture probability (temporal effect or change)
    - Best suited for three or more search occasions
  - $M_b$: a unit’s behavior changes after the first capture (behavioral effect or change)
    - Best suited for three or more search occasions
Employer estimation: general model requirements and assumptions

- General model requirements:
  - Have at least two capture occasions
    - *Example*: Two agricultural survey iterations
  - Capture occasions occur over a short period of time
  - Search procedures are conceptually equivalent
    - *Example*: Survey forms and the type of search being conducted are the same

- Assumptions:
  - Population in question is closed:
    - The population is finite
    - Immigration into the population area is negligible
    - Mortality rates are negligible
    - *Example*: The size of the closed population does not drastically vary over a short period of time
Employer estimation: overview continued...

- Log-linear model fitted with a Poisson Regression for capture-recapture experiments ($M_0$):
  1) Probability of a unit to experience a capture history, $\omega$,
     - $\Pr(\omega) = (1 - p)^t - \Sigma \omega_j p \Sigma \omega_j$
       - $t =$ capture occasions
       - $p =$ single capture probability to all units
       - $\Sigma \omega_j =$ the number of times the unit is caught
  2) Therefore, the expected number of units in the population having a capture history $\omega$ is:
     - $\mu_\omega = N (1 - p)^t - \Sigma \omega_j p \Sigma \omega_j$
  3) Expected frequency re-expressed as a log-linear model:
     - $\mu_\omega = \exp \left( \log(N(1 - p)^t) + \Sigma \omega_j \log \left(\frac{p}{1-p}\right) \right)$
  4) Fit a log-linear model:
     - $E(Y) = \exp(X\beta)$
       - $Y$ is equal to the $(2^t - 1) \times 1$ vector of the observed frequencies $n_\omega$
       - $X$ is a $(2^t - 1) \times 2$ design matrix
       - $\beta = (\gamma, \beta)^t$
  5) Abundance estimate:
     - $\tilde{N} = n + \exp(\gamma)$
     - $\exp(\gamma) = \exp \left( \log(N(1 - p)^t) \right) = N(1 - p)^t = N \times Pr(\omega_0) = \mu_0$
       - $\omega_0 =$ the unobservable capture history of zero capture
       - $\mu_0 =$ the expected number of units never captured
Employer estimation: analytical steps

**Descriptive statistics**
- Transform data to a usable format (matrix of capture histories)
  - Assign binary indicator for each capture occasion
  - Produce descriptive statistics for capture-recapture data

**Model fitting**
- Fit various loglinear models for a closed population
  - $M_0$, $M_t$, $M_b$

**Model selection**
- Produce fit statistics for the number of captures on each capture occasion and model performance.
  - AIC, BIC, standard error, etc.
  - Using model fit statistics select the model to be used for estimation

**Abundance estimate**
- Apply the selected model to compute the abundance estimation and 95% confidence interval of a closed population
Results: application to estimate industry firm abundance

- Method was applied to survey data collected from 2015 and 2017:
  - 2015 and 2017 data was made compatible in order to apply this technique
    - 2017 survey data was far more granular in terms of what crop-varieties were allowed to be reported
  - Comparison against adjusted 2017 average annual firm counts by six digit NAICS code from QCEW
    - QCEW firm counts were adjusted to meet the scope of the survey
    - Ratios of eligibility were extracted from 2015 (74%) and the most recent 2018 (80%) survey disposition records and then averaged
    - Therefore, on average 77% (0.77) are considered eligible under the scope of the survey
      - Example: $100_{\text{total firms}} \times 0.77_{\text{eligible}} = 77_{\text{adjusted firms}}$
## Results: Industry estimates

<table>
<thead>
<tr>
<th>Industry (NAICS)</th>
<th>Adjusted 2017 QCEW firm count</th>
<th>Abundance estimate</th>
<th>AE</th>
<th>APE</th>
<th>Low 95</th>
<th>Hi 95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other vegetable and melon farming</td>
<td>225</td>
<td>181</td>
<td>44</td>
<td>20%</td>
<td>128</td>
<td>284</td>
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<tr>
<td>Apple orchards</td>
<td>588</td>
<td>549</td>
<td>39</td>
<td>7%</td>
<td>483</td>
<td>633</td>
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<tr>
<td>Grape vineyards</td>
<td>156</td>
<td>149</td>
<td>7</td>
<td>4%</td>
<td>118</td>
<td>201</td>
</tr>
<tr>
<td>Berry (except strawberry) farming</td>
<td>176</td>
<td>180</td>
<td>4</td>
<td>2%</td>
<td>137</td>
<td>253</td>
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<tr>
<td>Fruit and tree nut combination farming</td>
<td>18</td>
<td>13</td>
<td>5</td>
<td>28%</td>
<td>8</td>
<td>&gt;37.5</td>
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<tr>
<td>Other noncitrus fruit farming</td>
<td>713</td>
<td>695</td>
<td>18</td>
<td>3%</td>
<td>625</td>
<td>782</td>
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<tr>
<td>All other miscellaneous crop farming</td>
<td>209</td>
<td>217</td>
<td>8</td>
<td>4%</td>
<td>129</td>
<td>442</td>
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</table>
# Results: Crop estimates

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Apples</td>
<td>943</td>
<td>830</td>
<td>1086</td>
<td>316</td>
<td>292</td>
<td>98</td>
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<tr>
<td>Berries</td>
<td>249</td>
<td>191</td>
<td>344</td>
<td>61</td>
<td>87</td>
<td>22</td>
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<tr>
<td>Cherries</td>
<td>759</td>
<td>665</td>
<td>880</td>
<td>235</td>
<td>276</td>
<td>86</td>
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<tr>
<td>Grapes</td>
<td>266</td>
<td>200</td>
<td>379</td>
<td>70</td>
<td>76</td>
<td>20</td>
</tr>
<tr>
<td>Pears</td>
<td>513</td>
<td>418</td>
<td>649</td>
<td>131</td>
<td>159</td>
<td>41</td>
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</tbody>
</table>
## Results: Crop variety estimates

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>Braeburn</td>
<td>105</td>
<td>42</td>
<td>&gt;315</td>
<td>11</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>Apple</td>
<td>Cripps pink</td>
<td>113</td>
<td>45</td>
<td>&gt;338</td>
<td>5</td>
<td>25</td>
<td>2</td>
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<tr>
<td>Apple</td>
<td>Fuji</td>
<td>360</td>
<td>247</td>
<td>577</td>
<td>61</td>
<td>81</td>
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<tr>
<td>Apple</td>
<td>Gala</td>
<td>646</td>
<td>506</td>
<td>859</td>
<td>133</td>
<td>159</td>
<td>33</td>
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<tr>
<td>Apple</td>
<td>Golden delicious</td>
<td>439</td>
<td>324</td>
<td>634</td>
<td>82</td>
<td>110</td>
<td>21</td>
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<tr>
<td>Apple</td>
<td>Granny smith</td>
<td>455</td>
<td>278</td>
<td>865</td>
<td>54</td>
<td>74</td>
<td>9</td>
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<tr>
<td>Apple</td>
<td>Honeycrisp</td>
<td>476</td>
<td>327</td>
<td>757</td>
<td>56</td>
<td>113</td>
<td>15</td>
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<tr>
<td>Apple</td>
<td>Red delicious</td>
<td>423</td>
<td>310</td>
<td>618</td>
<td>63</td>
<td>121</td>
<td>20</td>
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Results: Crop variety estimates continued…

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</thead>
<tbody>
<tr>
<td>Berry</td>
<td>Blueberry</td>
<td>182</td>
<td>117</td>
<td>328</td>
<td>35</td>
<td>46</td>
<td>9</td>
</tr>
<tr>
<td>Berry</td>
<td>Raspberry</td>
<td>69</td>
<td>51</td>
<td>104</td>
<td>22</td>
<td>33</td>
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<tr>
<td>Berry</td>
<td>Strawberry</td>
<td>37</td>
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<td>105</td>
<td>9</td>
<td>12</td>
<td>3</td>
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<tr>
<td>Cherry</td>
<td>Dark red</td>
<td>444</td>
<td>332</td>
<td>641</td>
<td>40</td>
<td>200</td>
<td>18</td>
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<td>Cherry</td>
<td>Red</td>
<td>725</td>
<td>551</td>
<td>1001</td>
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<td>Cherry</td>
<td>Yellow</td>
<td>441</td>
<td>308</td>
<td>685</td>
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<td>Pear</td>
<td>Bartlett</td>
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<tr>
<td>Pear</td>
<td>Bosc</td>
<td>469</td>
<td>200</td>
<td>&gt;1406</td>
<td>18</td>
<td>57</td>
<td>3</td>
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<tr>
<td>Pear</td>
<td>D’anjou</td>
<td>355</td>
<td>248</td>
<td>557</td>
<td>60</td>
<td>86</td>
<td>15</td>
</tr>
</tbody>
</table>
Moving forward

- January 31st, 2019:
  - Survey administration and data collection closed
  - Worker survey response rate: 42.91%
  - Employer survey response rate (1/20/2019): 42.14%
- February 28th, 2019:
  - University of Washington delivers final survey data set to LMEA
- March, 2019:
  - Agricultural survey quarterly meeting to discuss worker estimation method
    - Announcement of date and time will follow shortly
  - Final employer and worker survey analysis and estimation
- April, 2019:
  - Conference call with all stakeholders presenting final results
    - Feedback period of approximately one week
  - Submission of final results to USDOL
    - Publication of final results is contingent upon USDOL
  - Begin administrative planning for 2019 survey iteration
References


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