Measuring the Employment Impact of Water Reductions

By Richard Howitt, Josué Medellín-Azuara, Duncan MacEwan
Department of Agricultural and Resource Economics and Center for Watershed Sciences
University of California, Davis
September 28, 2009

SUMMARY

Reductions in water supply to the Central Valley of California have spawned a controversy among economists regarding employment effects in the state. Two recent statements of different viewpoints are in Howitt et al. (2009a; 2009b) and Michael (2009). Howitt et al. presents a comprehensive analysis of revenue loss from changes in agricultural production due to water shortages as projected by the Statewide Agricultural Production Model (SWAP) which is then mapped into job losses using a regional Input/Output model (REMI). Michael points out that the job losses per million dollars of agricultural output used by Howitt et al. from the REMI model are substantially more than those estimated by Michael from aggregate data, and an earlier study by Sunding et al. (2008) based on the IMPLAN model. This technical note re-calculates the impacts using a current version of the IMPLAN model and compares and discusses results in other reports cited by Michael.

A comparison of the IMPLAN and REMI models, and of the data on which they are based, shows that the original REMI model estimate of 35,000 is an incorrect over-estimate. We re-estimate job loss impacts at 21,000 total jobs lost, of which 16,000 are due to drought alone and 5,000 are due to environmental pumping restrictions. Additionally, we conclude that predictions reported by Michael of only 6,000 jobs lost significantly underestimates the total incremental employment impact of water shortages.

Circulated estimates of 6,000 jobs lost by Michael are based on assumptions about the labor market for which we find no empirical evidence. In addition, previous studies (Michael 2009, Sumner 2002, Sunding 2008) use an IMPLAN production function that is calibrated against old data which reduces the importance of agricultural contract labor. Michael uses IMPLAN to calculate total job losses on the order of 13,000 (direct, indirect, and induced), but, he assumes there is a large agricultural labor shortage sufficient to adsorb the drought effect on labor demand and the influx into the agricultural labor supply from displaced construction workers. Using the labor supply shortage to imply a lower bound of zero he estimates agricultural jobs lost at 6,000.

When we recalibrate the IMPLAN model to reflect the full agricultural employment by including direct wages, agricultural contractors, and revenue loss by crop proportions (directly from SWAP),

the incremental loss in employment that we attribute to the water reductions in 2009 totals[1] 21,000 jobs. These employment estimates reflect the direct, indirect, and induced effects in the model, as shown in Appendix C.

INTRODUCTION

This purpose of this technical note (and previous work in Howitt et al) is to estimate the marginal (incremental) unemployment resulting from reductions in water exported from the Delta. Two approaches to this estimation can be characterized as a "top-down" approach using changes in the reported aggregate county agricultural employment data from the California Employment Development Department (EDD), and a "bottom up" approach that calculates reductions in surface water supplies and the consequent crop acreage and production reduction which is then mapped into jobs lost. The controversial step in the bottom up procedure is the link between reductions in agricultural output and the loss of agricultural jobs.

The top-down method of using EDD data is an aggregate statistical approach. The average annual EDD statistics for employment in crop production decreased slightly between 2005 and 2008 for Stanislaus, Merced, Fresno, Kings, and Kern counties. There are several problems with using a top-down aggregate statistical approach to measure the incremental effects in particular regions where the water reductions actually occur. In general, the problems with using changes in EDD agricultural employment data focus on the definition of an agricultural job. First, it is important to note the distinction between a Full Time Equivalent (FTE) job and a seasonal agricultural job. EDD data is reported in FTE jobs even though California agricultural work (especially among laborers whom the drought affects most) is highly seasonal. Using the EDD data (Appendix A) for total agricultural employment, the base industry[2] employment in any given month is approximately 138,100 workers. Deviations above this baseline employment can be considered as seasonal jobs which peak during the late spring through early fall months for planting and harvest. Using the EDD data, there is an average of 45,850 seasonal jobs in a month with a peak of 85,800 seasonal jobs in September. To determine how many months the average worker actually works we use the EDD data to calculate the total number of seasonal worker months and divide by the total number of workers over the year. On average, a seasonal worker works 25 percent of the year or about 3 months. Working three months out of the year (480 – 720 hours) is substantially less than a FTE job (12 month or 2000 hour). Consequently, when discussing reductions in agricultural output during the peak of the season it is important to differentiate between a job and a FTE job.

In addition to the important distinction between a FTE and a job, when FTE jobs are reported, there is potential difficulty in the EDD data with the definition of an agricultural job. According to the EDD employment data collection method[3] if someone worked for an agricultural employer for any

---

[1] Total job impact includes direct, indirect, and induced job losses. Direct effects represent the change in employment for the expenditures and/or production values specified as direct final demand changes. Indirect effects represent the change in employment caused by iteration of all other non-agricultural sectors purchasing from agriculture and/or the sectors with changes in demand. Induced effects represent the impact on all regions' industry caused by changes in expenditure of household income as a result of the direct and indirect effects.

[2] Year 2006, crop farming agricultural production in San Joaquin and Tulare Valleys including agricultural services

[3] http://www.labormarketinfo.edd.ca.gov/article.asp?articleid=179

period (greater than 1 hour) during the week that contains the 12th day of the month, the EDD counts that person as an employed farm worker for that month. Clearly, the number of "employed" workers recorded by EDD will be influenced by outside factors such as employment in construction or hospitality industries. If supply of farm workers increases due to a downturn in construction at the same time that demand is reduced due to drought, there will be increased competition for existing agricultural jobs. Due to the seasonal nature of many farm jobs, as discussed previously, this will translate into shorter periods of employment. The effect on aggregate EDD data would be an increase in the number of workers "employed" although, in reality, total farm jobs are decreasing. It is important to note that we are not suggesting that shorter periods of employment are solely responsible for upward bias in employment statistics; rather, we are suggesting it is an important component which should be considered when analyzing aggregate EDD data.

The most important problem with using changes in aggregate EDD data to measure changes in employment in specific locations is that county level statistics do not account for the dramatic difference in the impact of water cutbacks between the east and west sides of many valley counties. In fact, EDD acknowledges this possibility when describing their data gathering method[4]. Using a bottom-up modeling approach with SWAP allows us to explore differences within regions and counties since changes in production occur within the more detailed CVPM regions. The aggregate county statistics cannot detect regional differences within a county. For example, in counties such as Fresno the east side has more plentiful water rights than the west side. Aggregate data does not differentiate between these regions whereas the east and west side of Fresno are two distinct regions in the SWAP model.

Regardless of the aggregate level of unemployment, it is clear that increased land fallowing reduces farm jobs available and increases the level of local unemployment. This report offers empirical evidence to support this claim, derived using linked agricultural production and employment models. Furthermore, due to rigid water right priorities, the effects of these water cuts are concentrated on the Westside Valley communities and in Kern County. A detailed regional model can reflect such localized effects.

THE REMI MODEL

The REMI model used by Howitt et al. (2009a) was based on output and employment from the North American Industrial Classification System (NAICS) code 115115 (see Appendix A) for agricultural labor contractors. Both the employment and output for the NAICS code 000111, defined as crop production, were omitted from this version of REMI. Since the omitted sector was agricultural production (000111), job loss multipliers were based solely on the agricultural services sector (115115) which has significantly higher jobs per unit output. The result was an incorrect job loss estimate of 46.5 jobs per $1 million agricultural output, as emphasized by Michael.

The job loss numbers reported in previous model runs should be replaced by those presented in this text. In the rest of this analysis we use an updated version of the IMPLAN model used by the three comparison studies cited by Michael to correct employment loss estimates.

---

[4] http://www.labormarketinfo.edd.ca.gov/article.asp?ARTICLEID=179&SEGMENTID=3

Updated Analysis with IMPLAN

We estimate the impact of the reductions in Delta water exports and drought on employment in all sectors using an updated version of the IMPLAN model (www.IMPLAN.com) using 2006 data. To update the contract and direct wage employment, we recalibrated the IMPLAN production function to yield the ratio of wage labor to contract labor reflected in the EDD statistics in Appendix A-1. In the base IMPLAN model, contract labor represented about 30% of the labor force which is consistent with the situation in California in 1985 (31% according to Mason and Martin 2007), but contract labor has increased to about 50% today (EDD data suggests 54%). Since the default production function in IMPLAN has this ratio at just over 30 percent it suggests that the model has not been recalibrated recently. IMPLAN allows for user defined calibration of the production function, we used this feature to achieve the empirically supported 50% contract labor proportion. Calculations to show the proportion of the total crop production labor force accounted for by agricultural contractors are in Appendix A-1. Updating the production functions in IMPLAN (for farm cropping sectors) had two steps. First, we ran the model with a nine percent (reduction in output as reported by SWAP in Howitt et. al.) reduction in crop farming industry output. We obtained a ratio of indirect versus direct impact, and used that ratio to update the agriculture and forestry sector coefficient in the production function to reflect the 2006 EDD data. IMPLAN automatically rebalances all other sectors to accommodate the increased labor contractor share.

Using the updated IMPLAN model, the same agricultural revenue losses from Howitt 2009b were used to drive the models. Crop farming revenue losses totaling $710 million (2008 dollars) were estimated, as in Howitt et al. (2009b), using the SWAP agricultural production model for three agricultural regions (orange area in Figure 1) and broken down by crop sector for consistency with the IMPLAN model. Revenue losses in regions south of the Delta represent the main focus of this report and total $703 million. In aggregate, these translate into revenue losses of 9% in the South Central Valley (San Joaquin and Tulare regions) and 0.2% for the Sacramento Valley. We disregard the small Sacramento Valley effects in this analysis.

The revenue losses by crop and region were then used for the employment impact analysis in IMPLAN. Total value of agricultural output from SWAP for the same sector and region in the same year is valued differently than that in IMPLAN. In aggregate SWAP has a total farm gate output value of approximately $ 8.2 billion whereas IMPLAN has a total output value of approximately $12.6 billion. This is because IMPLAN data is from the Department of Commerce and data from SWAP is in farm gate values, with prices and yields directly from County Agricultural Commissioners Reports. In IMPLAN, revenue losses include outlays to all other sectors in the regional economy and value added, and reflect value to final consumers. As such, using $710 million in farm gate values from SWAP as a direct change in the IMPLAN agricultural sector would be incorrect. To accurately translate SWAP output into IMPLAN we use the 9% revenue reduction and apply it to IMPLAN. Then the aggregated percent changes in agricultural revenues from SWAP (aggregated from SWAP crop groups to IMPLAN crop sectors) are used to estimate the change in crop sector output due to water shortages in the IMPLAN model.

The counties included in the estimation are listed in Table 1, left of Figure 1, however we omit results for regions in the Sacramento Valley. The agricultural sectors evaluated in IMPLAN correspond to NAICS code 111, with 2006 output totaling $12,589 million, for San Joaquin and Tulare regions. Based on the aggregated results from the SWAP model, the distribution of changes in production over IMPLAN cropping sectors is as follows: Grains 13.2%, Vegetables 5.74%, Nuts 5.54%, Fruit 4.5%, Cotton 31.4%, and All Other 20.4%. Appendix C shows that IMPLAN job loss estimates due to 2009 water shortages are 21,056 for the San Joaquin and Tulare regions. This result implies losses of approximately 30 jobs per $1 million (2008) of agricultural sector output.

Results are considerably higher than two of the three previous IMPLAN based California studies cited by Michael which had equivalent values of 11.7, 23.8, and 16.4 jobs per $1 million agricultural output. This difference is partially due to updating the proportion of agricultural contract labor to reflect the current situation in California. Verbal contact with the authors of two of the cited studies confirms that the default production function in IMPLAN was used for the analysis in which contract labor accounted for 30 percent of the labor force, compared to current data and studies that show 50 percent. Even with the smaller contract labor proportion, the Sumner (2002) study in Michael's table 5.5 shows a total employment effect for agricultural production of 22.24 jobs per $1 million agricultural output (the direct effect is 14.68). As another basis for comparison, Social Accounting Matrix (SAM)-type multipliers for the sector in Tulare range from 1.61 for grain farming to more than 3 for vegetables and cotton farming. IMPLAN results from the updated model are shown in Table 1.

Table 1. Updated IMPLAN model results.

Job Loss Impacts (Drought and Smelt)	Direct	Indirect	Induced	Total
Updated IMPLAN Analysis	6,376	6,978	7,702	21,056

Table 2. Counties included in the regions analyzed.

Sacramento	San Joaquin	Tulare
Amador	Calaveras	Fresno
Butte	Contra Costa	Kern
Colusa	Madera	Kings
El Dorado	Mariposa	Tulare
Glenn	Merced	
Lake	San Joaquin	
Lassen	Stanislaus	
Modoc	Tuolumne	
Nevada		
Placer		
Plumas		
Sacramento		
Shasta		
Sierra		
Solano		
Sutter		
Tehama		
Yolo		
Yuba		

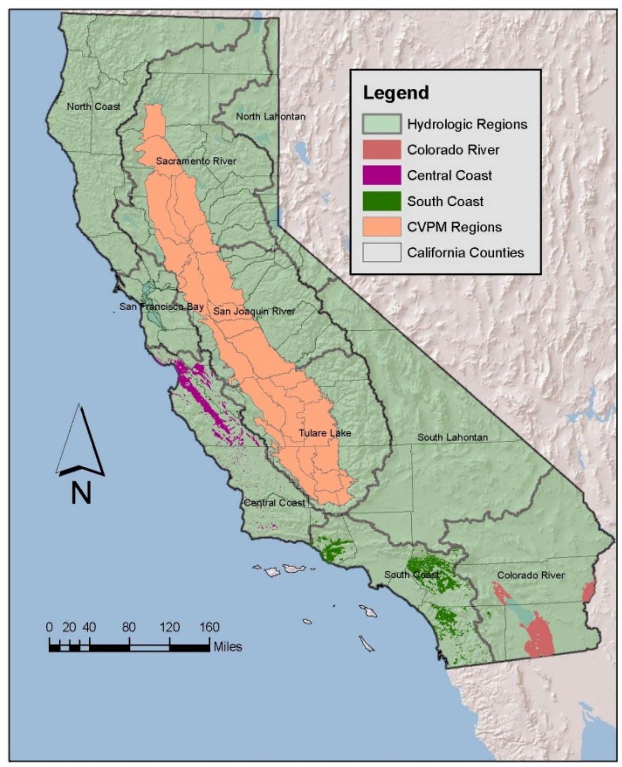


Figure 1. SWAP model coverage for the drought impact study.

A complete comparison of IMPLAN results with and without dedicated environmental flows (referred to as drought plus Smelt and drought only, respectively) is shown in table 3, below. In order to differentiate between total job losses and job losses attributable solely to drought (and additionally only to Smelt) we re-ran the SWAP model to generate impacts for a situation where there are no pumping restrictions due to Smelt in addition to the total water cut scenario summarized above.

According to preliminary estimates from the California Department of Water Resources (DWR), environmental flow requirements accounted for about 500 taf in 2009 which is just over 15 percent of the SWP and CVP supply for applicable regions south of the Delta. DWR estimates that 1.6 maf were lost due to drought with an additional 500 taf due to environmental flow requirements[5]. To incorporate this into the SWAP model we included the DWR data of surface water availability under drought and groundwater pumping capacities by region with increased SWP and CVP deliveries of 500 taf (~15%) to regions south of the Delta. The resulting output was summarized and prepared for IMPLAN using the same method as described above.

As table 3 shows, total job losses due to both drought and Smelt pumping restrictions are estimated at 21,056 and job losses due to drought alone are estimated at 16,000. In other words, of the 21,056 estimated jobs lost 5,056 can be attributed solely to Smelt (~25%).

Under drought alone, revenue reductions are 7% for San Joaquin and Tulare regions with the addition of Smelt pumping restrictions revenue reductions are 9% for the same regions. Several important points need to be emphasized regarding these results. First, the "job multiplier" is not constant over all revenue reductions (22.8 and 30.0 for comparison in our analysis) which emphasizes the importance of the marginal analysis used in previous studies by Howitt et. al. This is because job and income impacts depend on the types of crops removed from production, in addition to the magnitude of the revenue reductions. In our analysis, considering drought only against drought and Smelt, an additional 15 percent reduction in water (due to Smelt) leads to a 20 percent decrease in revenues which increases direct and indirect plus induced job losses by 33 and 31 percent, respectively.

[5] http://www.waterplan.water.ca.gov/docs/meeting_materials/ac/08.13.09/4.preparing-dry2010-pres.pdf

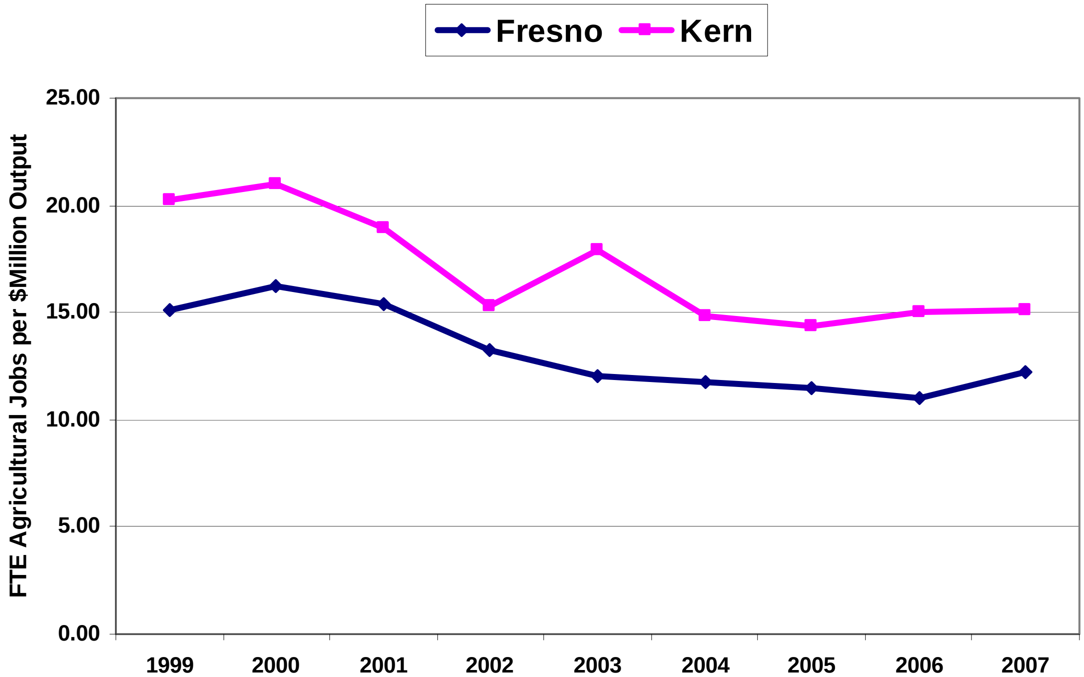
Table 3. Comparison of Job Loss Estimates with and without including dedicated Smelt flows.

Estimate	Drought Only	Drought and Smelt
Agricultural Revenue Losses (Millions $2008)	$586 (~7%)	$703 (~9%)
Impact Model Run (Sector Output % Reductions)	11% grains, 4.0% vegetables, 4.4% Nuts, 3.0% fruits, 27.9% Cotton and 14.6% all other.	13.2% grains, 5.7% vegetables, 5.5% Nuts, 4.5% fruits, 31.4% Cotton and 20.4% all other.
Direct Agricultural Sector Job Losses (thousands)	4.8	6.4
Indirect and Induced Job Losses (thousands)	11.2	14.7
Total Job Loss (thousands)	16.0	21.1
Total Job Loss/$Million in Ag. Farm Gate Revenue Loss (Jobs/$Million 2008)	22.8	30.0

LABOR SHORTAGE AND SUPPLY

In his report on current estimates of employment losses due to drought Michael states "farm output increased while employment declined as a number of factors have reduced the labor intensity of agriculture" (Michael 2009, p. 2). Various news reports and online blog postings have suggested that a decline in the labor intensity of agriculture may be enough to offset any employment losses from fallowed land. One reason for a slight downward trend in labor use is improvements in average production technology have occurred in recent years, such as round-up-ready cotton and mechanical grape harvesting, (Mason and Martin 2007). Analysis of county Agricultural Commissioners Reports of total farm labor productivity between 1999 and 2008 in Fresno and Kern counties, and the corresponding employment numbers from the EDD do not show evidence of the necessary level of increased productivity. Figure 2 below shows the labor productivity relationship over the last nine years with a mean of 13.19 and 16.97 in FTE jobs per million dollars output in Kern and Fresno Counties, respectively. Employment is measured in Full Time Equivalent (FTE) units and output in millions of dollars per year, in $2008. The slight downward trend is consistent with technological progress. The relationship is relatively constant, and offers no support for decoupling farm employment from production.

Figure 2. FTE Agricultural Field Jobs per $ Million Output ($2008).

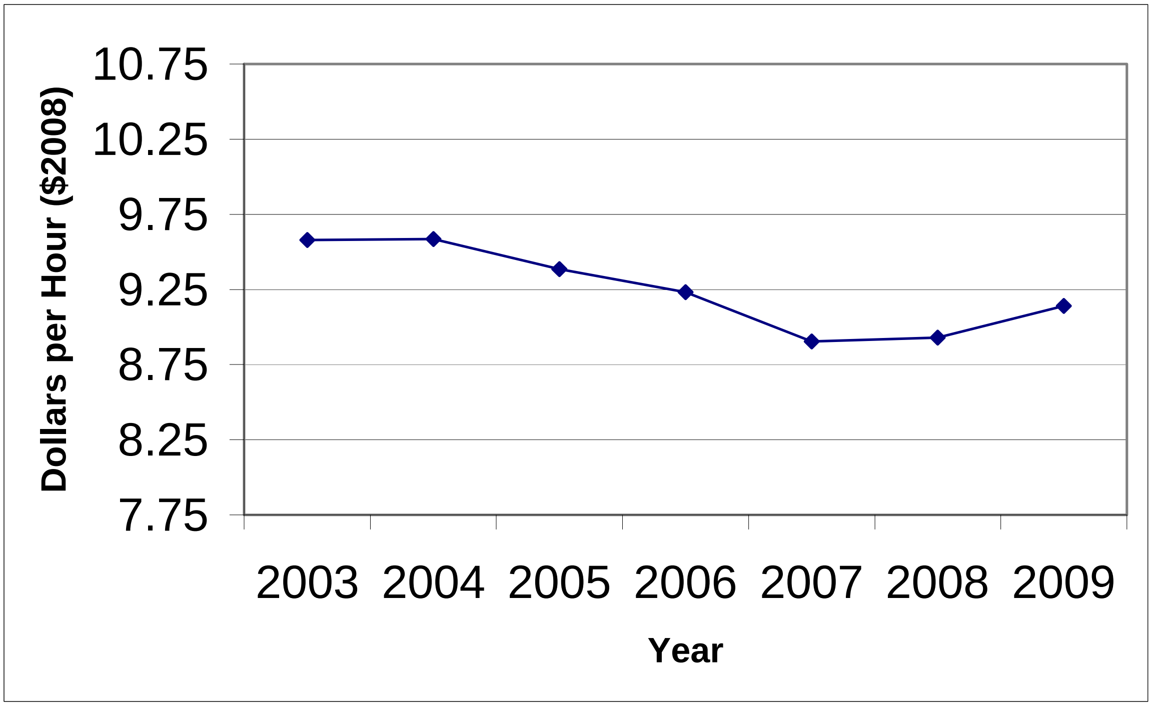


A central theme in Michael (2009) is that there is a severe shortage of agricultural laborers in the Central Valley. His analysis is based on the hypothesis that the labor shortage is severe enough to offset both a decrease in labor demand due to the drought and an increase in labor supply due to the collapse of the construction industry and other related industries. To justify his claim he offers anecdotal evidence and a simple supply and demand graphical analysis. The graphical analysis is presented as one explanation for the paradox of increases in employment as measured in some regions by month to month EDD data. We find no empirical evidence to support his hypothesis.

Michael reasonably suggests that the collapse of the construction business has flooded the market with 47,000 unemployed construction workers. If some of these workers shift to agriculture, combined with the 9% decrease in aggregate farm output due to water shortages, it is much more likely that there is a labor surplus, not shortage. Even assuming only 50 percent of construction workers enter the agriculture labor market this amounts to 24,000 new potential agricultural employees. Based on the IMPLAN database (Appendix B) this is a 29 percent increase in the workforce, combined with a 9 percent contraction in farm output, and consequently it would require a severe pre-existing labor shortage for there to be little impact on rural employment. Overall, July 2009 unemployment in the San Joaquin Valley was 16%.

If the market was out of equilibrium due to a labor shortage, economic theory suggests significant upward pressure on wages, thus we would expect to see real wages increasing among farm laborers. The empirical evidence does not support this. Figure 3 shows real hourly wages for farm workers from EDD (Code 45-2092) since 2003 in California. Nominal wages are expressed in real terms using the Employment Cost Index (ECI) prepared by the Bureau of Labor Statistics to convert wage data into real terms (www.bls.gov). Real wages are trending *down* over the relevant time frame suggesting a labor surplus or market in equilibrium, not shortage. Furthermore, a brief review of the literature on California agriculture labor (some of which are cited by Michael) does not offer any empirical evidence of a prolonged agricultural labor shortage in California. This includes both peer reviewed articles and research reports (for example, Devadoss and Luckstead 2008, Martin 2006, Martin 2007, Mason and Martin 2007).

Figure 3. Real California Farm Worker Wages ($2008).



Michael uses an assumption of a severe labor shortage to infer a lower bound of zero jobs lost due to water shortages. He finds a range of 5,000 to 7,000 direct and 10,000 to 13,000 total jobs using UC Davis (Howitt et al 2009b) revenue loss numbers, and his version of the IMPLAN model. However, he also states that "a large labor shortage could mean that a drought that reduces the amount of land under cultivation could theoretically have zero impact on total farm employment." Based on this assumption, Michael suggests a lower bound of zero employment impact and uses a midpoint of 6,000 total jobs lost as his projection. We find no empirical evidence that a labor shortage exists in California, based on previous studies and empirical evidence in the form of real wages and average agricultural labor productivity that have been relatively constant over the last decade in California. These data imply it is highly improbable that productive land could be fallowed without seeing a reduction in agricultural employment.

CONCLUSIONS

The point of contention in recent reports is the effect of agricultural revenue losses on agricultural employment. Since the focus is on marginal job losses due to drought and water shortages, we argue that a bottom-up modeling approach to measuring incremental regional changes is more accurate than an aggregate statistical top down approach. The top-down approach focuses on aggregate statistical data that does not accurately capture within-county differences, offers limited "forecasting" power, and reflects the difficulty in defining agricultural jobs in the EDD data.

The main focus of this report is to evaluate ways of measuring the employment loss per unit of agricultural revenue loss. The initial REMI model multipliers used for the employment impact analysis in January (Howitt 2009a) were found to be incorrect due to omitted sectors in the REMI model. This has been corrected using IMPLAN with 2006 data to more accurately model the marginal impact of job losses due to drought and water shortages in the Central Valley. The IMPLAN model has been updated from previous studies to more accurately reflect the proportion of contract to wage laborers in California. In our updated analysis, agricultural revenue losses of 9% in the San Joaquin and Tulare regions were found to cause 21,056 in total job losses.

A second focus in this report was to analyze the findings of Michael's 2009 report and determine if 6,000 jobs was a reasonable estimate. Some difference in the two IMPLAN-based analyses is explained by the difference in updating the production functions in IMPLAN to account for recent contract labor data. The greatest difference is in Michael's assumption of severe regional labor shortages, which he uses to justify reducing his IMPLAN employment effects by half.
In conclusion, while initial employment impact estimates using the REMI model were incorrectly overstated, re-calculating impacts of water reductions using a new IMPLAN model leads to estimates of significant total job losses of more than 21,000 jobs in the San Joaquin and Tulare regions.

REFERENCES

Devadoss, S., and Luckstead, J. "Contributions of Immigrant Farmworkers to California Vegetable Production" Journal of Agricultural and Applied Economics, 40(3), December 2008: 879-894.

Martin, Philip, "Farm Labor Shortages: How Real? What Response?" Center for Immigration Studies, November 2007.

Martin, Philip, "Immigration Reform: Implications for Agriculture" Agricultural and Resource Economics Update, April 2006, http://www.agecon.ucdavis.edu/extension/update/articles/v9n4_1.pdf

Mason, B., and P. Martin. ''California's Farm Labor Markets.'' Conference on Immigration Reform and Agriculture. Internet site: http://migration.ucdavis.edu/cf/files/BertJune_2007. pdf (Accessed September 04, 2009).

Michael, J., "Unemployment in the San Joaquin Valley in 2009: Fish or Foreclosure?" August 2009, Eberhardt School of Business: Business Forecasting Center, University of the Pacific.

Howitt, R. E., D. MacEwan, and J. Medellin-Azuara 2009a. Economic Impacts of Reductions in Delta Exports on Central Valley Agriculture, in *Agricultural and Resources Economics Update*, edited, pp. 1-4, Giannini Foundation of Agricultural Economics, Davis, California.

Howitt, R.E., Medellin-Azuara, J. , MacEwan, D.J. (2009). Measuring the Employment Impacts of Water Reductions. Technical Note, Department of Agricultural and Resource Economics and Center for Watershed Sciences. University of California, Davis, California. 6 pp. Available at < http://swap.ucdavis.edu > last access September 2009.

Sumner, Dan, "Agriculture's Role in the Economy" in Measure of California Agriculture. 2002.

Sunding, D, N, Ajami, S, Hatchett, D Mitchell, and D. Zilberman. "Economic Impacts of the Wanger Interim Order for Delta Smelt" Berkeley Economic Consulting, Berkeley, Ca. December 2008.