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Foundations for Hawaiʻi's Green Economy: Economic Trends in Hawaiʻi Agriculture, Energy, and Natural Resource Management

BY

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1. Executive Summary

As the most isolated population on the planet, Hawai‘i has a unique opportunity to build a green economy at a manageable scale and be a model for integrated green growth. Hawai‘i’s people depend on imports for 95% of their energy and 85-90% of their food, at an estimated annual cost of between $7 billion and $8 billion (Leung, 2008; DBEDT, Energy Resource Coordinator’s Annual Report, 2011). Hawai‘i also exports most of its agricultural production, with only approximately 10% of agriculture produced in the islands consumed locally (Leung, 2008).

Statewide, there is strong support for greater sustainability evidenced by the Hawai‘i 2050 Sustainability Plan, New Day Hawai‘i economic plan, Hawai‘i Clean Energy Initiative, Rain Follows the Forest watershed initiative, Hawai‘i Green Jobs Initiative, active sustainability programs in all four counties and many more state, county and local efforts. Many of these plans and initiatives include targets to measure progress, including:

- 70% clean energy by 2030 – 40% from renewable resources, 30% from conservation.
- Double local food production by 2030 – 20-30% of food consumed in Hawai‘i is locally produced.
- Double the level of protection of priority watershed areas over the next 10 years – 20% of priority mauka forests protected.

A recent national survey by the U.S. Bureau of Labor Statistics estimates “green jobs” in Hawai‘i accounted for 2.7 percent of the total 2010 workforce, slightly higher than the national

average of 2.4%. These people work in renewable energy, energy efficiency, pollution reduction, greenhouse gas reduction, recycling, organic agriculture, sustainable forestry or environmental conservation. Global economic studies report that transition to a green economy results in a higher gross domestic product (GDP), net increase in jobs over time and increases in wealth, particularly gains in "natural capital"—the goods and services that healthy ecosystems provide to society (e.g., water, soil, food, fuel, materials, and medicines). These green economy benefits depend on good natural resource management and investment in training and education of a green workforce (UNEP, 2011).

This report provides the first comparison of standard economic indicators for three sectors that are key to future sustainability in Hawai‘i - renewable energy, agriculture and natural resource management (NRM). Economic information has long been collected for many sectors in Hawai‘i, including agriculture and energy, but no systematic surveys have been conducted on the NRM sector to date. With support from The Nature Conservancy and Hau‘oli Mau Loa Foundation, the University of Hawai‘i Economic Research Organization was tasked with characterizing this important part of Hawai‘i's economy, in terms of number and types of jobs, salaries, and annual expenditures. Major findings across these green sectors are:

- Promising future job opportunities for Hawai‘i's youth in renewable energy and natural resource management. Renewable energy jobs showed very high annual growth of 23% over the past five years, while the total energy sector increased roughly 1.7%.

- Though the natural resource management sector is much smaller in size, NRM jobs were estimated to increase roughly 1.5% over the past five years. Over the same period, the agricultural sector and the state as a whole experienced negative growth rates of -2.1% and -1%, respectively.

- Oil prices play a very significant role in the state economy. Total energy expenditures in Hawai‘i reached $7 billion in 2008, approximately 5% of spending and 10.4% of the state’s total GDP.[1]

- This study estimates Hawai‘i natural resource management expenditures were at least $465 million in 2010 (ca 10% of the energy sector), with likely future growth in both public and private sector management of watersheds, invasive species, marine resources and other NRM priorities.

- While almost all agricultural economic indicators declined dramatically from 1970 to 2007 and total Hawai‘i agriculture expenditures were only $530 million in 2010, the number of farms increased steadily from a low of roughly 3,000 in 1974 to more than 7,500 in 2007, suggesting a transition to small diversified farms. Growing public interest in food self-sufficiency, promotion of “buying and eating local” and assistance programs for local small-scale farmers may strengthen this essential sector.

Table 1. Green Jobs in Hawai‘i

Sector	FTE Jobs	Past 5-yr FTE Growth Rate	Expenditures
Energy	14,027	1.68%	$4,894.22 M
Renewable Energy	1,228	23.01%	-
Agriculture	6,300	-2.09%	$529.8 M
NRM	3,279	1.51%	$465.61 M

Though preliminary, these findings can help inform policy and decision-makers of the current contribution and future potential of these sectors. In particular, they suggest opportunities to strengthen Hawai‘i’s economy and sustainability at the same time:

- Local training and education programs to match anticipated “green job” growth, especially in renewable energy and natural resource management.

- Strategic use of government incentives (e.g., solar tax rebates) and funding (e.g., Rain Follows the Forest watershed initiative) to accelerate growth in key sustainability sectors.

- Include appropriate economic indicators for the natural resource management sector in economic reports and projections of green growth and green jobs prepared by State and other government agencies.

[1] In this report, energy sector jobs and GDP estimates include only the direct impacts and exclude the indirect and induced impacts.

- Invest in valuation of the State's natural capital to help policy makers, business leaders, and the public understand their value and make appropriate investments in maintaining or improving the State's natural resource assets.

- Identify and track basic economic indicators for all key "sustainability sectors" in Hawai'i to focus public attention on progress toward a green economy.

Recent research indicates that effective collaboration across sectors to "move the needle" on priority community goals is significantly strengthened by shared data and learning (White House Council for Community Solutions. 2011). This initial review of economic trends in three key sustainability sectors should be used to advance work by the Hawai`i Green Growth Initiative and others to jointly develop practical, public sustainability indicators that guide statewide action and accountability.

2. Background

Understanding trends in various sectors of Hawai'i's economy can help the State make important decisions about future investments. Plantation agriculture was the backbone of Hawai'i's economy during the 20th century but has declined significantly over the past 60 years, creating a vacuum for new development and also opportunities for transition and diversification. Energy is essential to all other industries, and impacts the cost of living and quality of life for the majority of residents.

Natural resources are a key component of Hawai'i's culture and economy, yet economic planning and policy analysis—as in many other states—are to a large extent conducted independently of environmental or natural resource management. Quantifying trends in the natural resource management sector would, therefore, help to fill a current information gap and facilitate an integrated policymaking approach.

It is clear from previous studies that Hawai‘i’s natural capital is highly valued and should be managed accordingly. For example, Kaiser et al. (1999) estimate that the Ko‘olau watershed provides forest benefits valued between $ 7.4 and $ 14 billion, comprised of water resource benefits ($4,736-9,156 million), species habitat benefits ($487-1,434 million), biodiversity benefits ($0.67-5.5 million), subsistence benefits ($34.7-131 million), hunting related benefits ($62.8-237 million), aesthetic values ($1,040-3,070 million), commercial harvest ($0.6-2.4 million), and ecotourism ($1,000-2,980 million). Hawai‘i’s coral reefs alone are estimated to generate at least $10 billion in present value, or $360 million per annum (Cesar and van Beukering, 2004). Another recent study considering the value to all U.S. households finds that increasing the current size of marine protected areas in Hawai‘i from 1% to 25% and restoring five acres of coral reefs annually would generate $34 billion per year (Bishop et al., 2011).[2]

While many studies that place value on Hawai‘i’s natural resources have been undertaken in recent years, little is known about the economic impacts generated by agencies charged with protecting and managing these important resources in Hawai‘i. To that end, an online survey of natural resource managers in Hawai‘i was conducted, and the results are summarized in section 6 of this report.

3. Methods

This report describes trends in Hawai‘i’s agriculture and energy sectors based on four economic indicators: employment, average salaries, total expenditures, and share of State GDP.

[2] Cesar and van Beukering (2004) use data from various sources and the Simple Coral Reef Ecological Economic Model (SCREEM) to estimate the tourism, fishing, amenity, property, research, and biodiversity values generated by the 410,000 acres of reef area surrounding the main Hawaiian Islands. Bishop et al. (2011) develop and implement a hybrid contingent-valuation/stated-preference method to estimate the value, aggregated over the entire number of households in the United States, of protecting and repairing coral reefs in Hawai‘i.

A comparison of standard economic metrics (employment, expenditures, GDP, education, salaries) evenly across all sectors would be ideal. However, not all metrics were available for all industries, and consequently reported trends and comparisons across sectors were limited to publicly available data. The data used to estimate the size of the agriculture and energy industries over time come from a number of federal and state sources (Table 2).[3]

Table 2. Data sources for economic metrics by sector

Sector	GDP	Expenditures	Employment	Salary	Education
Agriculture	*HDOA (2005)*	*USDA-NASS (2007)*	*Schmitt (1977), DLIR (2011a)*	*DLIR (2011b)*	*USDA (2011)*
Energy	*DBEDT (2011)*	*EIA (2010)*	*DBEDT (2011)*	*N.A.*	*N.A.*
Renewable Energy	*N.A.*	*N.A.*	*DBEDT (2011)*	*N.A.*	*N.A.*
NRM	*N.A.*	*This report*	*This report*	*This report*	*This report*

N.A. = not available

GDP —the net value of production for a given sector, i.e., the total sales after subtracting purchases from all other sectors—is often viewed as one of the most comprehensive measures of a particular sector in the economy. However such a metric, which requires dollar values of produced goods or services, is not particularly amenable to characterizing the NRM sector because the ecosystem services and goods generated or protected by NRM efforts are typically not traded in conventional markets. While attempts have been made to value many of Hawai'i's natural resources (e.g., Bishop et al., 2011; Cesar and van Beukering, 2004; Kaiser et al., 1999), estimating GDP would also require quantitative estimates of ecosystem goods and services directly generated from management efforts or,

[3] Data on expenditures and salaries was adjusted to 2011 dollars using an inflation calculator available online at: http://www.bls.gov/cpi/cpicalc.htm. The CPI inflation calculator uses the average Consumer Price Index for a given calendar year. This data represents changes in prices of all goods and services purchased for consumption by urban households. This index value has been calculated every year since 1913. For the current year, the latest monthly index value is used.

alternatively, the reduction in those goods and services that would have occurred in the absence of management. Since such estimates are generally not available, section 6 in this report focuses on employment and expenditures in the NRM sector.

At present, no indicators are available to quantify the size and economic importance of natural resources management in Hawai‘i. All of the NRM information in this report was collected through a new survey released for the first time in 2011. The online survey (see, Appendix) was disseminated to 166 organizations engaged in one or more aspects of natural resources management in Hawai‘i. Ninety-one (or approximately 60%) of the contacted organizations responded to ten questions related to NRM expenditures, employment, employee characteristics, and salaries.[4]

The survey was designed to provide data that can be compared to other green industries in the state, such as agriculture and renewable energy. Unlike the agriculture and energy sectors, however, this report is only able to provide a current snapshot of the existing NRM sector in Hawai‘i. Information on the following economic indicators was collected: current employment numbers, past/expected growth in employment, average salaries, and total expenditures. It is our hope that the results from this initial survey will provide the first data point in a long time-series of future surveys, so that trends in the NRM sector can be meaningfully compared to those in other important sectors of Hawai‘i’s economy.

Results from the survey complement two recent reports entitled “Hawai‘i’s Green Workforce: A Baseline Assessment” (DLIR, 2010) and “Innovation and Technology in Hawai‘i: An Economic Workforce Profile” (CREC, 2008). The DLIR assessment estimated 11,145 green

[4] While this is not necessarily a representative sample, we feel that 60% is an acceptable response-rate, and the reported results will serve as a useful baseline for future surveys.

jobs in the private sector, which accounts for 2.4% of private employment in the state. The 3,279 NRM jobs estimated in the current report include largely non-private agencies (county, state, and federal government; university; non-profit), with only 53 of those positions attributed to the private sector. The difference in private sector job count is due primarily to the way green jobs are defined.[5] For example 2,552 and 1,264 jobs are attributed in the DLIR report to generating energy and energy efficiency respectively, whereas energy is considered separately from the NRM sector in the current report. After adjusting for potential double counting in the private sector, the 14,371 jobs accounted for in the two assessments serves as a lower bound for the total number of green and NRM jobs in the private and non-private sectors in Hawai'i. This is slightly lower than the U.S. Labor Department estimate of 15,593 green jobs in 2010 (2.7 % of the 586,772 people employed across the state). The CREC report categorized science and technology industries in the state into several commercial market segments, including renewable energy and environmental remediation and consulting services. It estimated 3,587 jobs in the renewable energy sector and 8,593 jobs in the environmental segment for 2007, most of which were related to environmental consulting, specialized engineering, and architectural design.[6] Given that only 10% of the 8,593 were categorized as public-sector jobs, most of the environmental technology segment is likely

[5] In the DLIR survey, a green job was defined as one which "makes a positive impact on the environment or energy sustainability," and belongs to one of five core areas: generate clean, renewable, sustainable energy; reduce pollution and waste, conserve natural resources; energy efficiency; education, training and support of green workforce; and natural, environmentally-friendly production. This definition is much broader than that of NRM jobs in the current report, thus including a larger number of qualifying job types.

[6] Job counts were calculated by compiling existing employment data according to several of the largest NAICS industries. Thus, if a particular company is identified as falling into the "environmental consulting" category, all of its employees are counted. The employment estimates in the current report were obtained by asking individual entities for the number of FTE jobs that could be classified as NRM, which in many cases is a much lower number than the total number of employees in the company or agency.

already captured in the green job counts. In the remainder of this report, NRM employment numbers are considered in conjunction with other industry metrics such as expenditures and salaries and compared with available data from the state's energy and agriculture sectors.

4. Agriculture sector overview

Hawai'i's agriculture sector has experienced a significant decline since 1970 due to competition from places with lower production costs, shifting consumer preferences and limited access to affordable land and water. The state's farm production-expenditures decreased by two-thirds between 1969 and 2007, and the amount of harvested cropland was nearly halved (NASS, 2007).

Over the same time period, farming as an occupation decreased from over 3.68% of total state employment to a little over 1%. However, "despite the continuing decline of sugar and pineapple production, the growth of diversified agriculture has more than made up their declines. As a result, agriculture remains a vital and steady contributor to Hawai'i's economy by providing a diversity of products and generating jobs and incomes" (HDOA, 2005).

This section combines historic U.S. Census Bureau data compiled in "Historical Statistics of Hawai'i" (Schmitt, 1977) with more recent data from the USDA's state-level agriculture censuses and the Bureau of Labor Statistics to give an overview of trends in expenditures, employment and salaries in Hawai'i's agriculture sector.

4.1. Employment in agriculture

Historical employment data gives one perspective on the diminishing role of agriculture in Hawai'i's economy. Similar to other parts of the US, the proportion of Hawai'i's workforce

composed of agricultural workers has declined from over 60% in 1900 to barely 1% in 2010. While the state's total number of workers increased rapidly between 1940 and 2010, during that same period the number of agricultural workers declined precipitously from over 52,000 to only 6,300 in 2010. This reflects the shift in Hawai'i's economy from resource-based to service-based. Figure 2 combines historic data from the U.S. Census Bureau with more current data (1972 and later) from Hawai'i's DLIR job counts, and shows the decline of farming as a percent of total employment in the state.[7] The proportion of agricultural workers relative to the rest of the state's economy declined most significantly between 1940 and 1960, due mainly to the end of the plantation era. Figure 2 gives a more detailed picture of the decline in agricultural jobs from 1972 to 2010.

4.1.1. Education in agriculture sector

Statistics on education levels for farm workers are available on a national level. According to the USDA (2011), 29% of all hired farm workers have less than a 9th grade education, compared with 3% of all U.S. wage and salary workers. Twenty percent of farm workers have some college education, compared to 62% of all U.S. wage and salary workers (USDA, 2011).

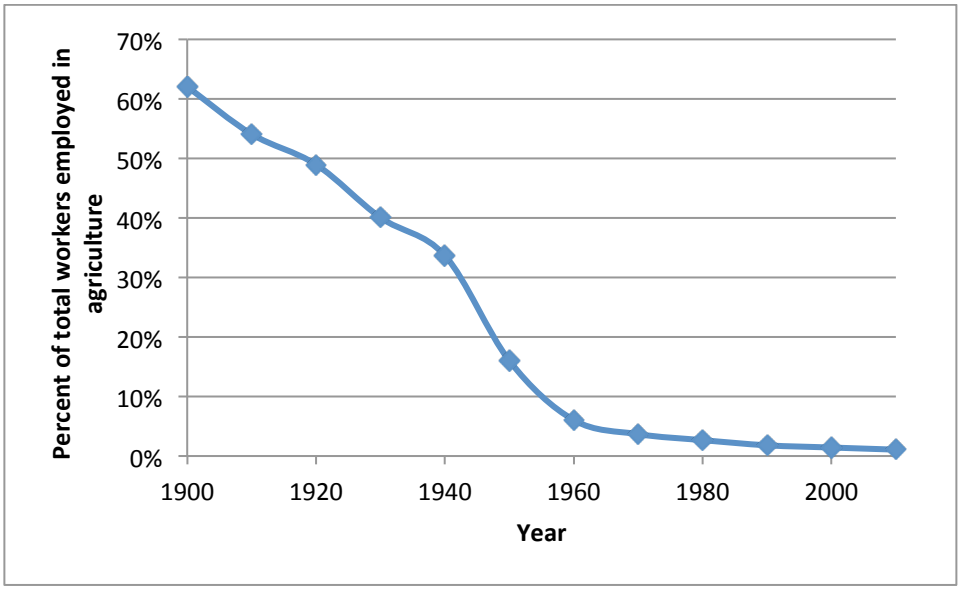
[7]Official census statistics on agricultural workers were compiled as early as 1866, but their coverage and comparability remained questionable until the end of the century. No distinction was made between field labor and workers employed in the sugar mills. The decennial U.S. census, first conducted in Hawai'i in 1900, introduced a higher degree of consistency into its industrial classifications, including a more scrupulous differentiation of agricultural workers and those engaged in milling, canning, and other forms of food processing. The decennial counts through 1930 referred to "gainfully occupied" persons, while those from 1940 forward presented data on the "civilian labor force." (Schmitt 1977).

Table 3. Agricultural employment in Hawai‘i, 1900-2010

Year	Number of agricultural workers[8]	Total number of workers	Farming as % of total
1900	55,931	90,172	62.03%
1910	54,742	101,194	54.10%
1920	54,803	111,882	48.98%
1930	61,811	154,262	40.07%
1940	52,391	155,531	33.69%
1950	27,235	170,075	16.01%
1960	13,790	228,050	6.05%
1970	12,170	330,790	3.68%
1980	10,800	404,100	2.67%
1990	9,500	528,400	1.80%
2000	7,900	551,400	1.43%
2010	6,300	586,900	1.07%

Source: Schmitt, Historic Statistics of Hawai‘i (1900-1972 data)
Hawai‘i Department of Labor and Industrial Relations, Job Count by Industry (1972-2010 data)

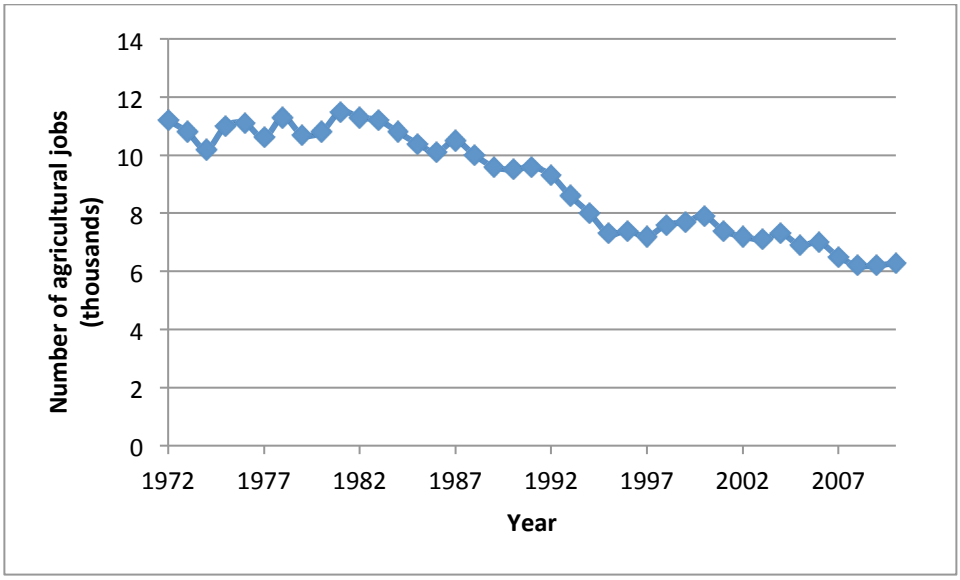
Figure 1. Farming as % of total employment in Hawai‘i, 1900-2010



Source: Schmitt, Historic Statistics of Hawai‘i (1900-1972 data)
Hawai‘i Department of Labor and Industrial Relations, Job Count by Industry (1972-2010 data)

[8]Agricultural workers are defined in this section according to the U.S. Census Bureau as workers in the industry titled “Agriculture, forestry and fisheries”. The U.S. Census was first conducted in Hawai‘i in 1900, and made the distinction between field labor and workers employed in the sugar mills, unlike previous statistics for Hawai‘i’s agriculture industry.

Figure 2. Number of agricultural jobs in Hawai'i, 1972-2010



Source: Hawai'i Department of Labor and Industrial Relations, Job Count by Industry 1972-2010

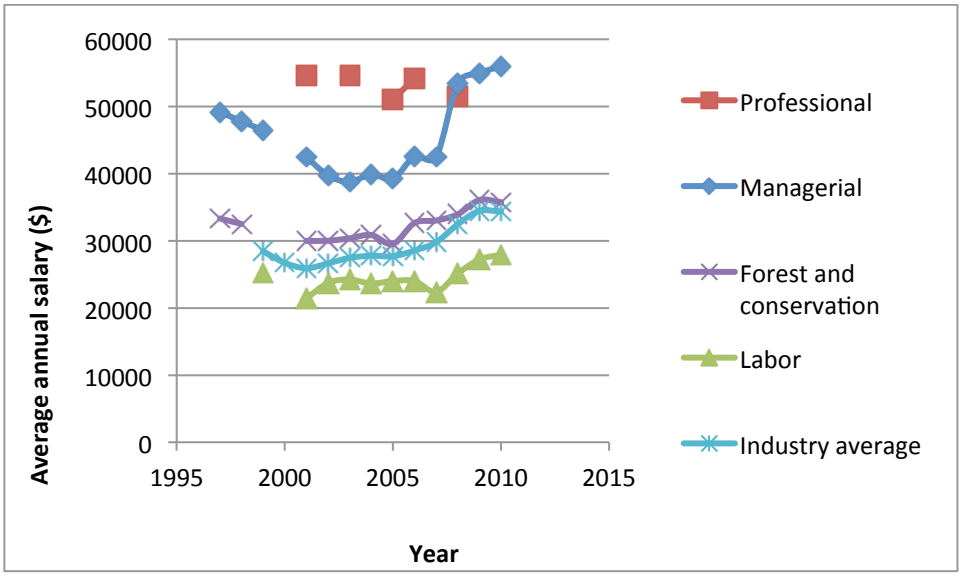
4.1.2. Salaries in agriculture sector

The Hawai'i Department of Labor and Industrial Relations publishes Occupational Employment Statistics (OES) data annually for all occupations in the state (DLIR, 2011b).[9] Occupations within the "Farming, Fishing and Forestry" sector have evolved significantly over time, making it difficult to describe trends consistently. This report gives salary trends for the following selected farming occupations: first-line supervisors and managers (managerial); agricultural inspectors (professional); farmworkers and laborers, crop, nursery, and greenhouse (labor); and forest and conservation workers (field technician). Although data is not available for each occupation type every year, Figure 3 presents major trends in salaries for categories of Hawai'i farming occupations since 1997. Salaries for all occupation types increased between 2001 and 2010, with the exception of agricultural inspectors (professional). Managerial salaries

[9] Semi-annual survey, most current data available online at: http://www.bls.gov/oes/current/oes_hi.htm#45-0000. Previous years back to 1997 are available in print form.

declined from 1997-2003, then increased to $56,022 in 2010. The average salary for all occupations in the "Farming, Fishing and Forestry" industry in the state-level Occupational Employment Statistics (OES) increased from $25,919 in 2001 to $34,346 in 2010.

Figure 3. Average salaries for farming occupations in Hawai'i, 1997-2010

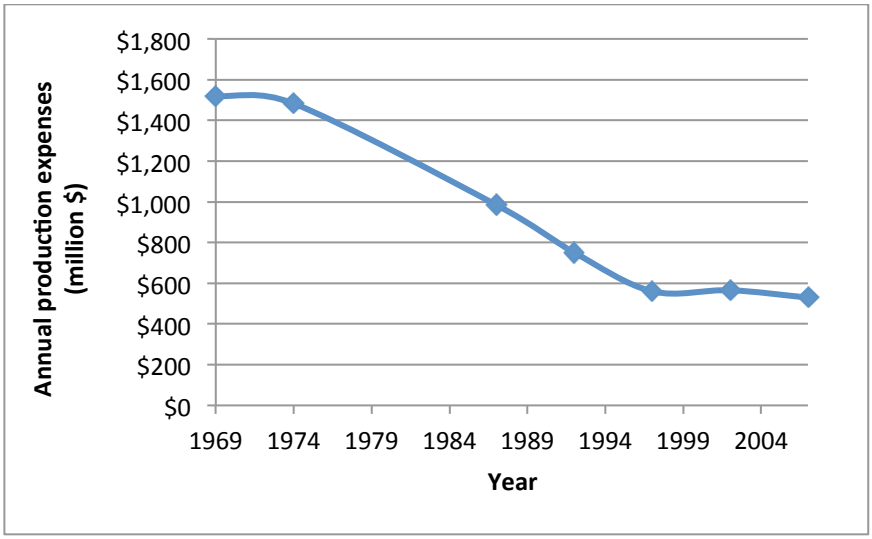


Source: Hawai'i Department of Labor and Industrial Relations. Occupational Employment Statistics (OES) 1997-2010.

4.2. Expenditures in agriculture

Agriculture sector expenditures are defined in this report as farm production expense totals, which have been collected in the U.S. Department of Agriculture's (USDA) state agriculture census every three to five years since 1969. Total farm production expenses include the following categories: livestock and poultry purchased, feed for livestock and poultry, commercial fertilizer, petroleum products, hired farm labor, interest expense, and agricultural chemicals. Figure 4 shows the decline in total farm production expenses for Hawai'i's agriculture sector from 1969 to 2007.

Figure 4. Farm production expense totals, 1969-2007



Source: USDA, National Agricultural Statistics Service (NASS). 2007 Hawai'i Agriculture Census Report.

Total farm production expenses declined from $1.5 billion in 1969 to $560 million in 1997, then remained relatively stable through 2007. During the same time period, the number of farms with harvested cropland increased from 2,750 to 6,044, suggesting a transition from large plantation style agriculture to the smaller diversified agriculture common throughout the state today.

4.3. Agricultural acreage and total number of farms

While data for farm expenditures and employment point to a long term decline in the agricultural sector, recent trends in farm acreage and numbers suggest that there is more to the story. Since 1959, the amount of land in farms has declined from nearly 2.5 million to roughly 1.1 million acres (Figure 5), while the total number of farms declined from 6,242 in 1959 to a low of roughly 3,000 in 1974, before steadily increasing to 7,521 in 2007 (Figure 6). Those numbers translate to a decline in average farm size from 394 acres in 1959 to 149 acres in 2007 (Figure 7). Together, these trends suggest that the sector has been steadily shifting

from large plantation-style agriculture to a larger number of smaller farms with diversified products.

Figure 5. Total land in farms in Hawai‘i, 1959-2007

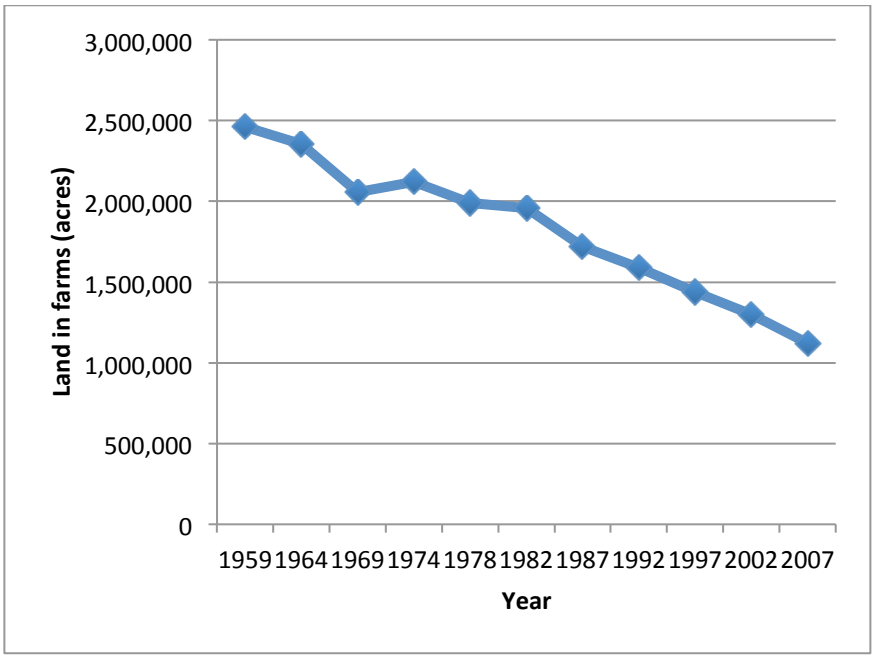


Figure 6. Total number of farms in Hawai‘i, 1959-2007

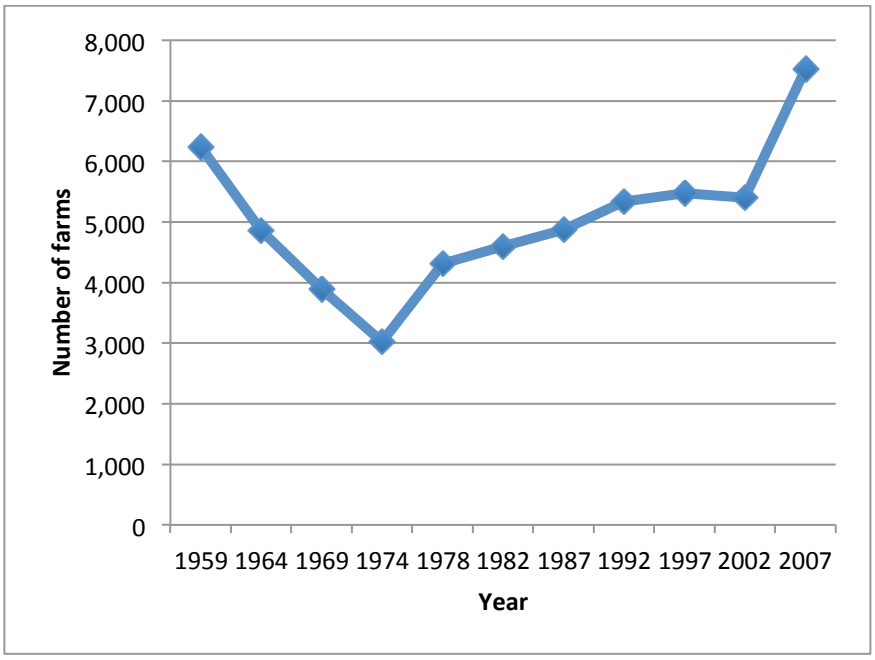
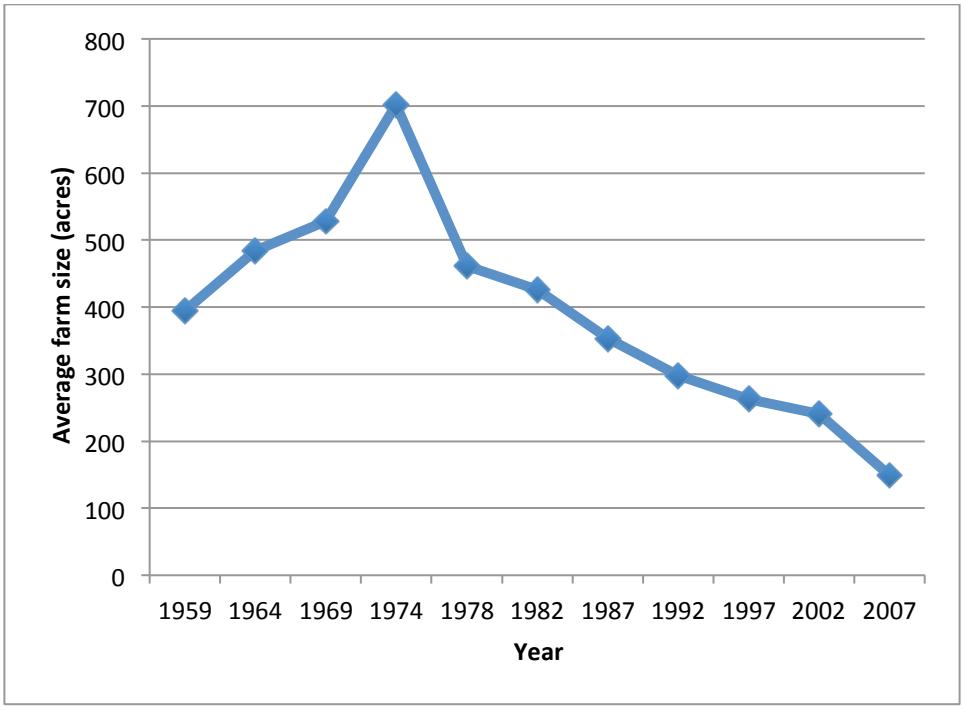


Figure 7. Average farm size in Hawai‘i, 1959-2007



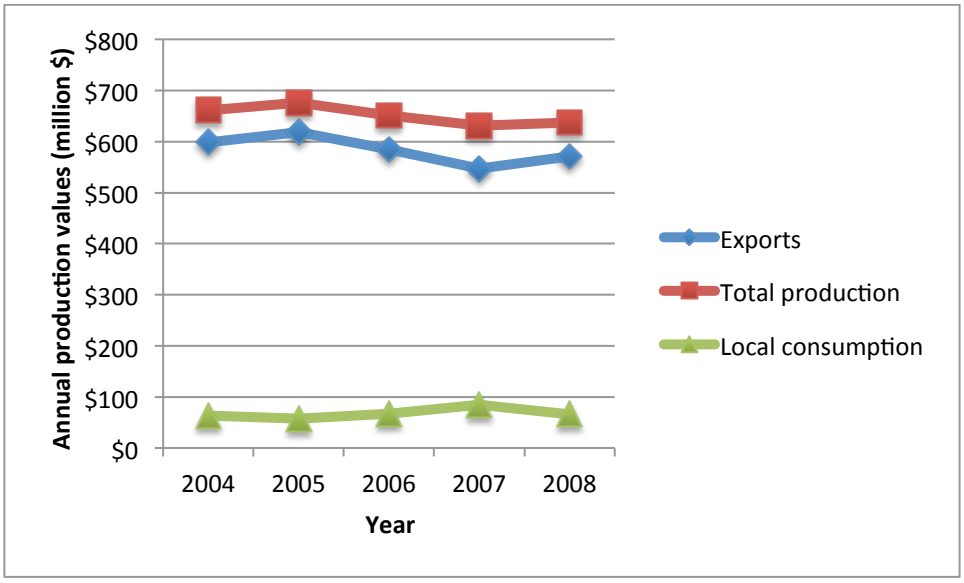
4.4. Consumption of locally produced agricultural goods

The value of agricultural exports (including exports to both the mainland and outside the United States) decreased from $599 million to $571 million over the period 2004-2008 in 2011 dollars (USDA-NASS, 2010). Over the same period, the total value of crops, livestock, and aquaculture produced in the state declined from $662 million to $637 million. The remainder of produced agriculture goods, which were consumed locally, increased in value from $62.7 million to $65.6 million or from 9.5% to 10.3% of the total produced value. Trends for total production value, export value, and locally consumed value are depicted in Figure 8.

These figures are comparable to those of previous studies which indicated that 85-90% of food consumed in the state is imported (Rocky Mountain Institute, 2007). Growing interest in food self-sufficiency (e.g. HDOA, 2008; Leung and Loke, 2008) has increased the promotion of

various ideas going forward, such as ramped up marketing for "buying and eating local" as well as assistance programs for local farmers. Although the trends depicted in Figure 8 are not definitive, demand for locally produced food may be on the rise.

Figure 8. Value of total, exported, and locally consumed agricultural goods, 2004-2008



4.5. Agriculture's contribution to state GDP

According to a Hawai'i Department of Agriculture report (HDOA, 2005), "the most comprehensive measure of the contribution of an industry is the value added or industry's gross domestic product (GDP) as it avoids possible double counting. The inclusion of other economic yardsticks such as employment, labor income and sales value provides a fuller picture of the performance of an industry." In terms of Gross Domestic Product (GDP), Hawai'i's agriculture sector follows the national trend of growing more slowly than the rest of the economy. The GDP of Hawai'i's agriculture sector grew at an annual rate of 2.8% from $687 million in 1997 (1.58% of state GDP) to $789 million in 2002 (1.57% of state GDP), then

decreased at an annual rate of 0.9% to $768 million in 2005 (1.21% of state GDP). This trend is opposite from the state's total GDP, which has increased more rapidly (8% annually) since 2002. Farm production has been relatively stable since 1997 but there has been a significant decline in forestry and fishing activities.

4.6. Recommendations for further agriculture sector analysis

To better understand food security in Hawai'i, we recommend tracking data on local food production and consumption. If collecting data on "production for local consumption" is not feasible, it can be presumably estimated as the difference between total production and total exports. An important question is how this should be measured (physical quantity like tons, value in dollars, etc.) and in what level of detail (individual types of vegetables or vegetables as a whole versus flowers versus livestock, etc.). Some of this is currently available in the USDA census.

If data can be collected from individual farmers regarding production for local consumption, then one may be able to see more interesting trends. For example, the data may show that most of the production from smaller farms is consumed locally, while a few big farms are doing the majority of the exporting.

Consumption data should also be tracked separately to get an idea of how much food consumed locally is provided by local farmers.

And, if the objective is to increase public awareness and promote locally-produced food, then a survey to elicit consumer preferences might also be useful, although not necessarily easy to implement.

5. Energy sector overview

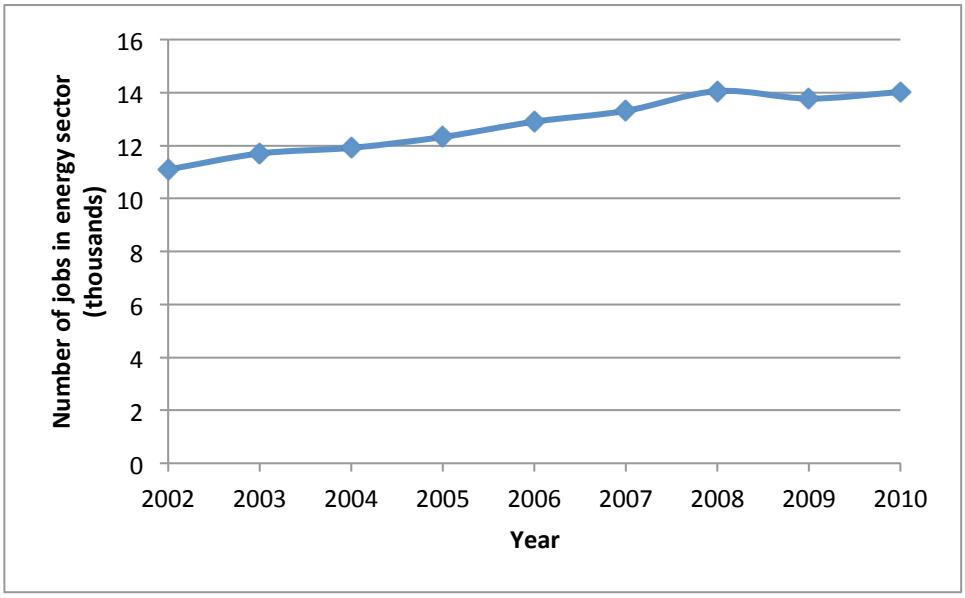
The energy sector has a strong influence on all other industries in Hawai‘i, since most of the economy relies on energy to operate. Yet it is difficult to identify trends in this important sector because it encompasses a number of different industries. A report released by the Hawai‘i Department of Business, Economic Development, and Tourism (DBEDT) in May 2011 defines Hawai‘i’s energy sector by aggregating industries classified by NAICS and related to the energy sector. This includes “businesses related to traditional energy such as petroleum and electricity and renewable energy such as electricity generation by hydro, wind, biomass and photovoltaic, as well as businesses producing or conducting research on bio-fuel.” This section draws upon data from the Federal Energy Information Administration (EIA) and the Hawai‘i DBEDT report, which incorporates data from over 90 government and private institutions.

5.1. Employment in energy

The definition of the energy sector used to determine employment numbers is broader than the definition used for energy expenditures. In addition to electricity generation and transmission, transportation fuel consumption, and electricity additions, energy sector employment falls under the following industries: oil and gas extraction; natural gas distribution; steam and air-conditioning supply; oil and gas pipeline and related structures construction; power line and related structures construction; electrical contractors and other wiring installation contractors; heating and air-conditioning contractors; petroleum refineries; petroleum and petroleum products merchant wholesalers; gasoline stations; fuel dealers; renewable energy construction; and renewable energy research and development (R&D).

Hawai‘i’s energy sector provided roughly 14,000 jobs in 2010, which is about 1.7% of total jobs in the state. This is considered a lower bound since most renewable energy projects in Hawai‘i are still in the planning or R&D stages, and many of the projects are carried out by non-utility industries. Energy sector jobs increased an average of 3.0% per year between 2002 and 2010 (Figure 9), significantly higher than the 1.3% growth rate of total jobs.

Figure 9. Energy sector employment in Hawai‘i, 2002-2010



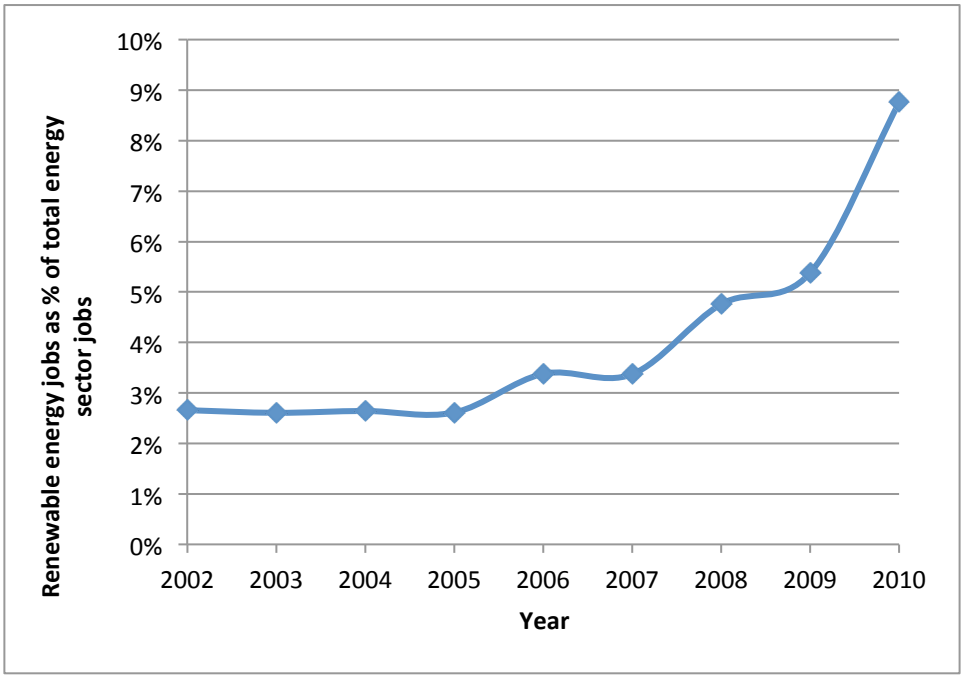
Source: Hawai‘i Department of Business, Economic Development and Tourism, "The Size of Hawai‘i's Energy Sector" 2011b.

The largest category of jobs in the energy sector are energy related construction and contractor jobs (37.4%), which increased an average of 2.2% per year between 2002 and 2010. The second largest category is energy products wholesalers, retailers, and fuel dealers, which made up 23.2% of total energy sector jobs. Jobs in this category increased 0.4% per year on average. Jobs in electricity/steam production, transmission and distribution made up 19.5% of the total energy sector.

5.1.1. Employment in renewable energy

Of the roughly 14,000 energy sector jobs in Hawai‘i in 2010, 1,228 were attributed specifically to renewable energy. Jobs in renewable energy construction and research increased more rapidly than jobs in the rest of the energy sector, at a rate of 19.5% per year from 2002 to 2010. Figure 10 shows the increase in the proportion of renewable energy jobs relative to the total energy sector jobs in Hawai‘i.

Figure 10. Renewable energy jobs as % of total energy sector jobs in Hawai‘i, 2002-2010



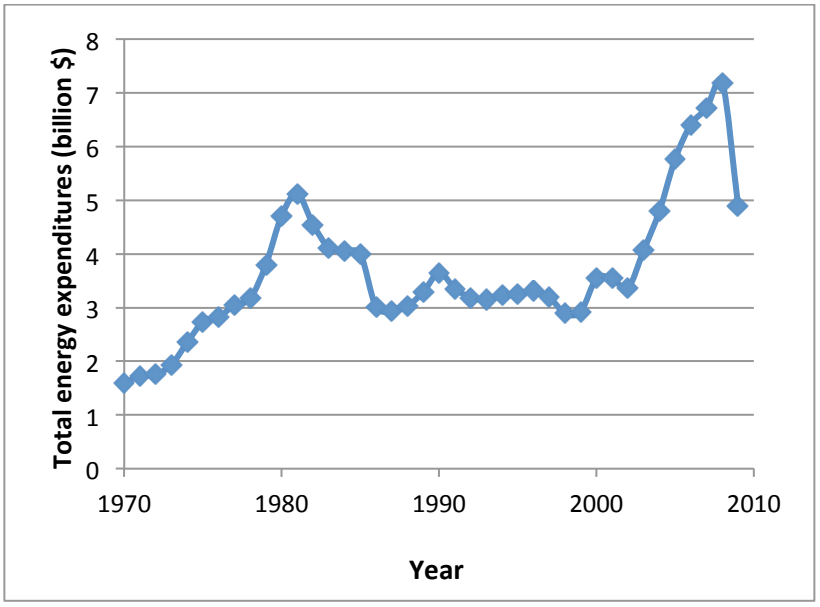
Source: Hawai‘i Department of Business, Economic Development and Tourism, "The Size of Hawai‘i's Energy Sector" 2011b.

Employment in the renewable energy (construction and R&D) as a proportion of the whole energy sector has increased by nearly 6% since 2007.

5.2. Expenditures in energy

Hawai'i's primary energy expenditures[10] increased 9.0 percent per year on average from 1970 to 2008 before experiencing a sharp decline in 2009. Annual expenditures remained roughly constant at $2 billion for most of the 1990's, then doubled between 2002 and 2005 to over $4 billion (EIA, 2010). As petroleum prices continued to increase, total energy expenditures in Hawai'i grew rapidly, reaching $7 billion in 2008, which accounted for approximately 5% of total spending and 10.4% of the state's total GDP.[11] Figure 11 includes electricity generation and transmission, transportation fuel consumption and electricity additions. Because EIA expenditure data is calculated using direct fuel costs, spending estimates are not available for hydroelectric, geothermal, wind, solar, and other renewable sources.

Figure 11. Energy expenditures in Hawai'i, 1970-2009



Source: Energy Information Administration, State Energy Data System - Hawai'i, 2010.

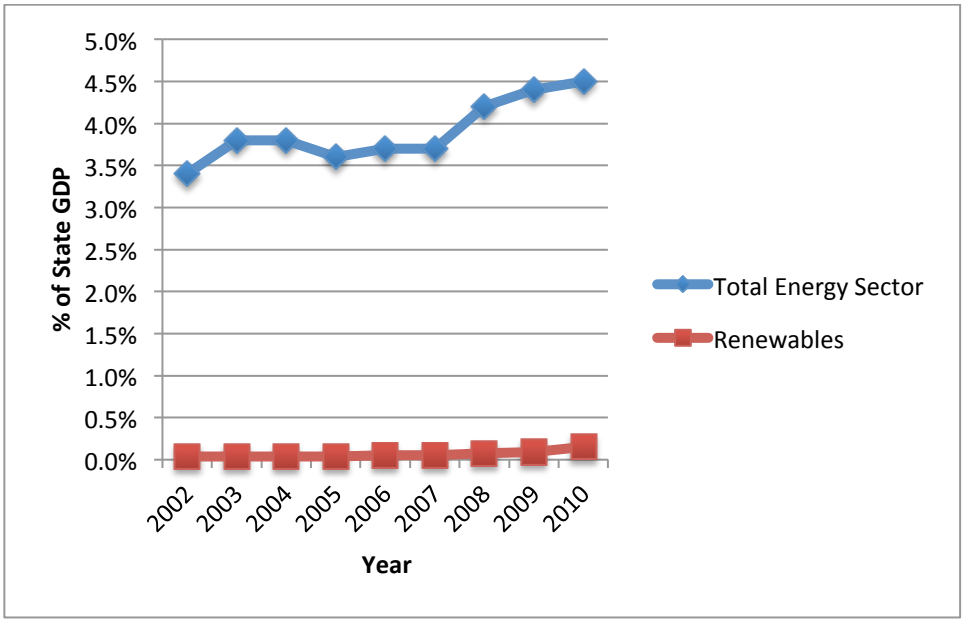
[10] EIA expenditure data is calculated by multiplying price estimates by consumption estimates, after adjusting for process fuel, intermediate petroleum products, electricity exports, and other consumption that has no direct fuel costs, i.e. hydroelectric, geothermal, wind, solar, and photovoltaic energy sources, and some wood and waste.

[11] In this report, energy sector jobs and GDP estimates include only the direct impacts and exclude the indirect and induced impacts.

5.3. Energy's contribution to state GDP

In 2010 Hawai'i's energy sector produced $3 billion of GDP, which made up 4.5% of the total state GDP of $67 billion (Figure 12).[12] . The electricity sector accounted for 53% of the energy sector GDP, while the petroleum industry accounted for 22.6% of the total GDP generated in the energy sector. Renewable energy construction and R&D were responsible for roughly 0.15% of state GDP, and that value has increased in both absolute and percentage terms over the past decade. The remainder of energy sector GDP can be attributed to the following industry NAICS-defined sub-categories: oil and gas extraction; natural gas distribution; steam and air-conditioning supply; oil and gas pipeline and related structures construction; power line and related structures construction; electrical contractors and other wiring installation contractors; and, heating and air-conditioning contractors.

Figure 12. Hawai'i's total and renewable energy sector GDP as % of state total



[12] Inasmuch as energy production is driven primarily by imported petroleum and state GDP excludes activity of imports, the percentage of total GDP attributed to the energy sector may overstate the contribution to total value produced. If total output is instead considered, the contribution is closer to 3%.

5.4. Recommendations for further energy sector analysis

If a comparison of similar metrics is desirable across the board, then expenditure data may be useful since jobs and GDP is already available for the energy sector. If one of the future goals is recommendations for investment in human capital, then data on types of renewable energy jobs, salary, and education might also be useful, similar to what was collected for the natural resources management sector below.

In general, simply continuing to collect data on GDP and jobs should be useful in the long run. As mentioned earlier in the report, there will likely be a surge in all metrics as planned projects (e.g., to meet Hawai‘i Clean Energy Initiative 2030) get underway. Thus one would expect the time series, even within the next 5 years, to look much different than the observed trends over the past decade.

6. Natural resource management sector overview

In this report, *natural resource management* (NRM) refers to the workforces who support terrestrial, freshwater, and marine ecosystem goods and services in Hawai‘i. Support of these ecosystems includes science, research, communications, outreach, fieldwork, management, decision-making, policy, training, and administrative support. Ecosystem goods include the physical components of an ecosystem such as all living organisms, air, soil, water, and sunlight, while ecosystem services are functions provided by these systems, such as carbon sequestration, nutrient dispersal and cycling, and air and water purification.

6.1. Employment in NRM sector

Because previous data on this sector does not exist, survey participants were asked to estimate, for their respective organizations, the number of full time equivalent (FTE) NRM employees in 2011, the number of FTE jobs lost or gained in the past 3-5 years, and the numbers of FTE jobs expected to be lost or gained in the next 3-5 years. In 2011, NRM jobs totaled 3,278.7 or 36.8 jobs on average per organization, with a standard deviation of 118.2. Total (average) FTE employees ranged from a low of 2.2 (1.1) for semi-autonomous organizations to a high of 1,401 (233.5) for state agencies. Total and average jobs for each sub-category are detailed in Table 4. For the entire NRM sector, 110.6 FTE positions were gained in the past 3-5 years, equivalent to a 1.5% annual (5-yr) growth rate. Survey respondents expect to gain 28.1 jobs in the next 3-5 years, or roughly 0.3 FTE employees per firm on average. The projected 0.17% annual growth rate may be conservative, owing to the perceptions about the current economic situation.

Table 4. Employment (FTE) in the natural resource management sector, 2011

Category	Respondents	Total	Mean	St. Dev.
Entire NRM sector	89	3,278.7	36.8	118.2
Past 5-yr FTE Growth [%/year]	-	110.6 [1.51%]	1.24	12.1
Expected 5-yr FTE Growth [%/year]	-	28.1 [0.17%]	0.34	7.7
State	6	1401.0	233.5	393.7
Federal	17	1085.9	63.9	64.7
Nonprofit	36	380.6	10.6	26.5
University	10	338.3	37.6	93.6
Private	15	53.2	3.5	4.9
Anonymous	1	13.0	13.0	-
County	2	3.0	1.5	2.1
Semi-autonomous	2	2.2	1.1	0.1

Note: 89 of 100 total survey participants provided employment estimates

Results from an earlier survey (DLIR, 2010) painted a more optimistic picture. In the private sector, employers projected the number of green jobs in Hawai'i to increase by 26% from 2010 to 2012, although the increase is due largely to expected growth in the renewable energy industry, which is considered separately from NRM in the current report.

Table 5. Job types, internships, and fellowships in the NRM sector

Job Types (# of times checked)*					
Scientist	44	**Tech. Info. Sys.**	20	**Comm./Outreach**	58
Field Tech.	59	**Bookkeeper**	33	**Lawyer**	18
Hunter	17	**Accountant**	24	**Planner**	30
Nat. Res. Manager	52	**Grants Mgmt.**	51	**Research/Analyst**	24
Cultural	30	**Fundraising**	22	**Training**	21
Construction	17	**Govt. Policy**	32	**Lab Tech.**	12
GIS/data manager	44	**Admin. Support**	65	**Other**	-
Internships†					
Paid	38	**Unpaid**	43	**None**	28
Fellowships‡					
Paid	16	**Unpaid**	11	**None**	65

*These are self-reported descriptions of the types of NRM positions currently filled in the respondent's organization. In some cases, a single FTE position falls into multiple categories.
†Internships are defined as short term (1-6 mos.) educational opportunities.
‡Fellowships are defined as medium term (>6 mos.) professional development opportunities.

Respondents were also asked which of 20 NRM job categories were included within their respective employee groups. The most selected categories included administrative support (65%), field technicians (59%), communications/outreach (58%), natural resource managers (52%), grants management (51%), GIS/data managers (44%), and scientists (44%). Survey participants were also allowed to fill in their own "other" job description. Other job types included inspection and quarantine, ecological and landscape design, low impact development, horticulture, engineering, law enforcement, permits, education, and archival. While over 70% of the organizations offer paid or unpaid internships, only 30% offer longer-

term fellowships. The complete data set on job types, internships, and fellowships is summarized in Table 5.

6.1.1. Education in NRM sector

Education levels and salary ranges varied widely across job categories within the NRM sector. Survey participants were asked about the average education level for each of the following job categories: administrative, field or technical, professional or managerial, and executive. Figure 13 illustrates the frequency of responses for each job category. Of the employees who perform administrative tasks, 75% hold at most a bachelor's degree. The distribution is most uniform for field technicians, with many workers at both ends of the education spectrum, while over 50% of managers and 60% of executives have completed a master's degree or higher.

6.1.2. Salaries in NRM sector

Figure 14 depicts a similar type of histogram for salary by job category. While over 50% of administrative support employees and field technicians start in the $20,000 to $40,000 range, a larger percentage of field technicians than administrative support employees (21% versus 16%) make between $51,000 and $80,000 per annum. As expected, most of the managerial and executive positions fall into higher salary categories, with nearly 40% of executives starting at over $80,000.

Figure 13. Average education level by job type in NRM, 2011

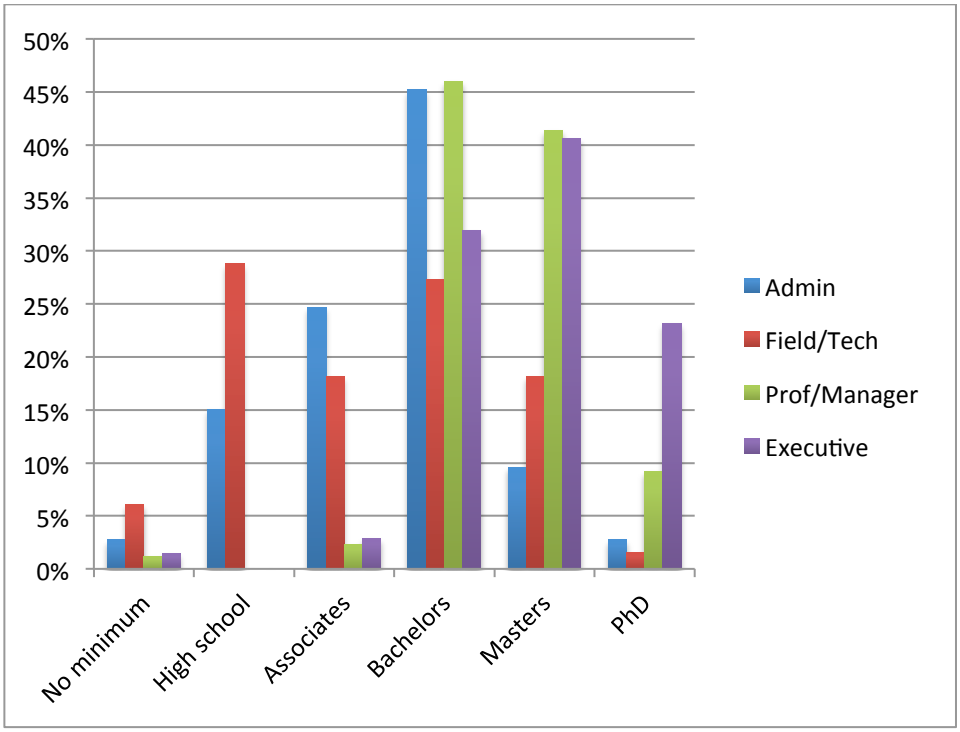
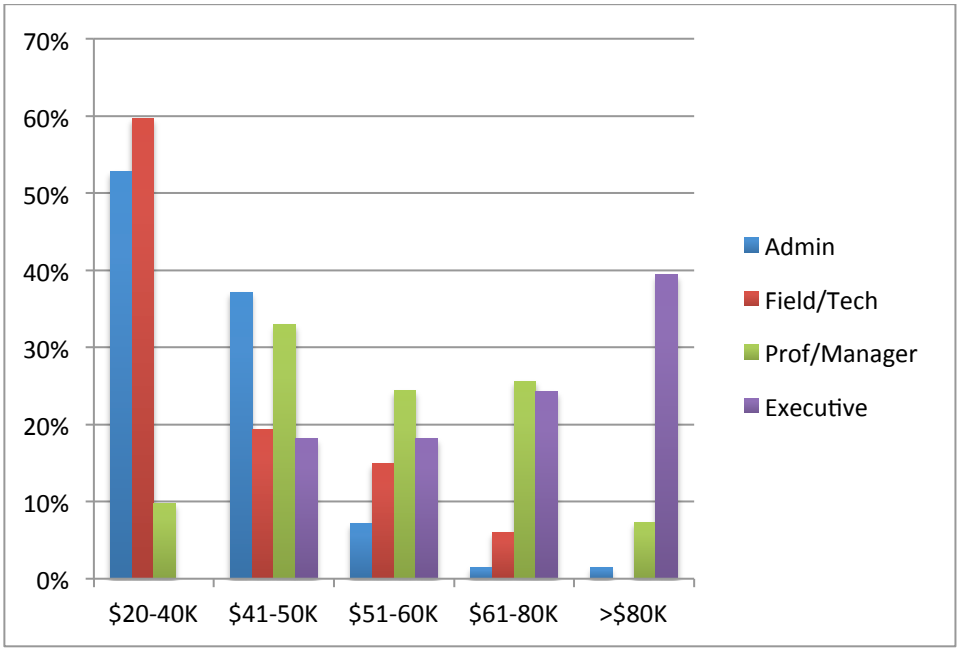


Figure 14. Average starting salary by job type in NRM, 2011



6.2. Expenditures in NRM

There are a variety of public agencies and private organizations involved in natural resource management. Looking at all of these agencies as a whole, NRM expenditures in 2011[13] totaled $465.6 million or $5.5 million per organization on average. The $20.7 million standard deviation suggests, however, that the average is being inflated by large government agencies. When organizations are separated into sub-categories (county, state, federal, nonprofit, private, semi-autonomous, and university), average expenditures range from a low of $147,280 for county departments to a high of $58.8 million for state government agencies. Total and average expenditures for each sub-category are detailed in Table 6.

Table 6. Expenditures* in the natural resource management sector, 2011

Category	Respondents	Total	Mean	Standard Deviation
Entire NRM sector	84	$465,606,733	$5,542,937	$20,700,493
County	2	$294,560	$147,280	$69,127
State	5	$294,156,045	$58,831,209	$69,009,291
Federal	17	$122,327,477	$7,195,734	$6,345,508
Nonprofit	35	$25,751,299	$735,751	$1,604,350
Private	14	$5,915,419	$422,530	$452,562
Semi-autonomous	2	$339,000	$169,500	$154,856
University	8	$15,547,933	$2,221,133	$4,479,586
Anonymous	1	$1,150,000	$1,150,000	-

*Expenditures included any expenses falling into the following categories: salaries and wages; fringe benefits; grants, contracts and "pass through" to other entities; capital improvement projects; and other. To avoid double counting, expenditures on grants, contracts and "pass through" were not included in total expenditures.

Note: 84 of 100 total survey participants provided expenditures estimates

6.3. Acreage managed by NRM sector

The Nature Conservancy (TNC) estimated that in 2005 the main Hawaiian islands had 1,900,000 acres of remaining healthy native ecosystems; less than half of the 4,000,000 acres of

[13] Survey participants were asked to estimate NRM expenditures using the most recent year/fiscal year for which data was available. In a large majority of cases, it is expected that this corresponds to the 2011 fiscal year.

healthy ecosystems which existed at the beginning of human habitation. The majority of the loss occurred after the arrival of Captain Cook, merely 235 years ago. Today, about 800,000 acres of land in the main Hawaiian islands have some kind of active conservation management, though approximately only 100,000 of these acres have achieved effective conservation to date (TNC Science Team, personal communication, April 27, 2012). TNC defines "effective conservation" as healthy ecosystems that are legally protected, and actively managed to reduce critical threats and bolster health and resilience to natural and human-caused disturbances. According to TNC, one of the primary limitations to achieving effective conservation on a large scale has been the lack of natural resource management funding.

Currently, eleven island-based Watershed Partnerships that work with more than 70 public and private landowners and partners on six islands include land areas of more than 2.2 million acres across the state with a mission to increase effective management and protection of mauka (upper elevation) watershed areas (HAWP, 2012, http://hawp.org). Also, five invasive species committees are working in the field on Kaua‘i, O‘ahu, Maui, Moloka‘i, and Hawai‘i island to control a variety of invasive pest species that affect the economy, environment, human health, and quality of life (ISCs, 2012, www.hawaiiinvasivespecies.org/iscs/). However, even with these partnerships, the Hawai‘i Department of Land and Natural Resources reports in its recent Rain Follows the Forest watershed management plan that only 10% or 90,000 acres of top priority forested watershed areas are sufficiently protected from threats such as weeds and invasive animals (DLNR, 2011).

6.4. Recommendations for further NRM sector analysis

Based on results from this preliminary data analysis, we have several recommendations moving forward. First, given the significance of the NRM sector in terms of jobs, expenditures, and growth potential, we believe that some form of the survey implemented for this report should be included in the Hawai‘i DLIR’s annual data collection program to ensure consistent and comparable data across relevant sectors.

Second, analysis of the collected data suggests that promising future NRM job opportunities exist for Hawai‘i’s youth. Although the agricultural sector reported negative job growth over the past five years, the NRM and renewable energy sectors experienced annual growth rates of 1.51 and 23.01 percent respectively. A continuing upward trend along those trajectories would produce roughly 50 NRM and 282 renewable energy jobs in 2012. However, past performance is generally not always a reliable indicator of future performance. The self-reported future job growth rate in the NRM sector of 0.17% reflects the expectation that such trajectories are indeed unsustainable in the long run. The estimate is likely to be overly conservative, however, given the current state of the economy, and we believe that actual job growth will be positive and somewhere between the past rate and self-reported expected rate.

We also recommend further development of public-private partnerships in the NRM sector, given the success of existing partnerships. The Hawai‘i Association of Watershed Partnerships, for example, comprises eleven partnerships that work with over 70 public and private partners seeking to manage approximately 2.2 million acres of watershed lands. The benefits realized by collaborative management include, but are not limited to, the ability to address large landscapes and threats affecting multiple habitats and species, leveraging limited

dollars for maximum benefits, allowing the pooling of resources and expertise to reduce redundancy, and providing education and jobs.

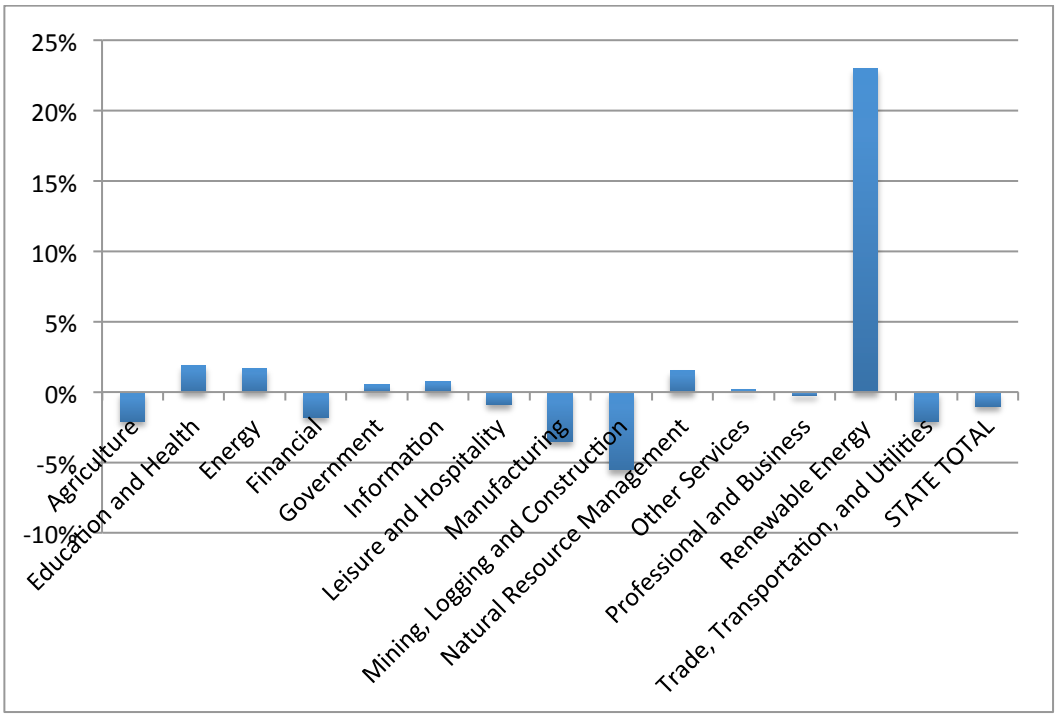
Lastly, we encourage investment in further research on the valuation of ecosystem services. Quantifying the benefits generated from NRM activities will bring more comparable metrics into the sector, and will help policy makers, business leaders, and the public better understand the value of efforts to protect the state's natural resources. A better quantitative understanding will also inform future decisions to allocate limited budgets for the maintenance or increased restoration of Hawai'i's ecosystems.

7. A sector comparison

In 2010, the state's energy sector employed roughly 14,000 (1,228 attributed specifically to renewable energy), while agriculture employed 6,300. NRM jobs in 2011 had the lowest total among the three sectors (3,279 FTE employees) but enjoyed a positive growth rate of 1.5% over the last 5 years, comparable to that of the energy sector as a whole. Agriculture and total state employment, on the other hand, experienced negative growth rates of -2.1% and -1%, respectively. Compared to ten other major sectors of Hawai'i's economy, growth over the past 5 years of renewable energy and NRM was relatively high, with only education and health, energy, government, and information experiencing positive growth over that stretch (Figure 15). Total annual expenditures were the highest for the energy sector ($4.9 billion); followed by

the agriculture sector ($530 million) and the NRM sector ($465.6 million).[14] Table 7 summarizes job and expenditure data across sectors.

Figure 15. Annual job growth rates by industry in Hawai'i, 2006-2011



Source: Bureau of Labor Statistics, "Economy at a Glance - Hawai'i" 2011

Table 7. Sector comparison

Sector	FTE Jobs	Past 5-yr FTE Growth Rate	Expenditures
Energy	14,027	1.68%	$4,894.22 M
Renewable Energy	1,228	23.01%	-
Agriculture	6,300	-2.09%	$529.8 M
NRM	3,279	1.51%	$465.61 M

[14] 2010 expenditure data was not available for energy and agriculture, so numbers from the most recent available year (2007 and 2009, respectively) were used instead for comparison.

8. Summary

Given the inseparable linkages between Hawai‘i’s environment and economy, and the considerable value of its natural resources from cultural, economic, and biological standpoints, policies and budgeting for environmental management should be undertaken with some knowledge of the natural resource management (NRM) sector. To date, no attempts have been made to characterize and aggregate data for the NRM sector in the state. This report is a first step in documenting the significance of NRM activities in Hawai‘i’s economy. Continuation of the survey into the future would allow for the development of a richer data set, capable of characterizing trends of economic indicators that could be compared directly to those in other sectors.

The agriculture sector has experienced a steep decline in both expenditures and jobs in the past several decades, while the energy sector has seen an overall increase over the same time period, with higher volatility in the years between. Results from an online survey indicate that although smaller than the other two sectors in terms of total jobs, the NRM sector has grown at a rate of 1.5% over the past 5 years, comparable to that of the energy sector (1.7%), while the agricultural sector and the state as a whole experienced negative growth rates of -2.1% and -1%, respectively. The NRM sector ranked third in terms of expenditures ($466 million), behind both agriculture ($530 million) and energy ($4.9 billion). Based on survey respondents’ expectations, jobs in the NRM industry are projected to grow at 0.2% annually over the next five years.

9. Recommendations

Going forward, we recommend that similar metrics be tracked for all three of these economic sectors, such as sector expenditures and employment information on numbers of jobs, types of jobs, job growth, education, salaries and wages. For the renewable energy sector, a survey like that done for the NRM sector could assist with collecting more detailed employment data. For the agriculture sector, it will be useful to track local production for local consumption to better understand food security issues and goals. And, since this report includes some of the first data collection on the NRM sector that we are aware of, we recommend that it be continued and expanded in order to build the kind of time-series information that can be tracked and meaningfully compared to other important sectors of the green economy.

Recent research indicates that effective collaboration across sectors to "move the needle" on priority community goals is significantly strengthened by shared data and learning (White House Council for Community Solutions, 2011). This initial review of economic trends in three key sustainability sectors should be used to advance work by the Hawai`i Green Growth Initiative and others to jointly develop practical, public sustainability indicators that guide statewide action and accountability.

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11. Appendix: Natural Resources Management Sector Survey

The Nature Conservancy (TNC), Hau'oli Mau Loa Foundation, and the University of Hawai'i Economic Research Organization (UHERO) are conducting this survey of organizations in Hawai'i engaged in one or more aspects of natural resources management. At present, no indicators are available to quantify the size and economic importance of Hawai'i's natural resources management sector. This survey is an important first step in documenting the significance of the natural resources management sector in Hawai'i's economy.

Please answer questions 1 through 3 to provide critical data for assessing the size of Hawai‘i’s natural resources management sector. Though questions 4 through 10 are optional, we would greatly appreciate your responses that will provide greater depth to this research. Please complete this survey by October 15, 2011.

All individual responses will be kept strictly confidential. Summarized findings that do not identify individual organizations will be available to all survey participants and may be shared with policy makers, others in natural resources management, the media, and the general public. While types or names of organizations may be identified as survey participants, no individual responses or data will be released.

If you have any questions please feel free to contact Mark Fox at TNC at (808) 587-6234 or mfox@tnc.org.

FOR THE PURPOSES OF THIS SURVEY, NATURAL RESOURCES MANAGEMENT IS DEFINED AS:

By natural resources management, we are referring to the activities and employees that support and care for natural lands, air, freshwater and marine systems in Hawai‘i. This includes fieldwork, science, research, regulation, planning, protection, management, hazard mitigation, communications, outreach, decision-making, policy, education, training, and administrative support.

1. Please provide your contact information so that we can reach you with any questions about your responses. Your individual responses will be kept confidential.

Name: _____

Company/Organization: _____

Email Address: _____

Phone Number: _____

2. Please complete the following chart with information on your organization's approximate annual expenditures for natural resources management in Hawai'i. You may use the most recent year/fiscal year for which you have data. *Note: Individual responses will be kept strictly confidential.

Category of Expense	Amount
Salaries and wages	
Fringe benefits *(may be expressed in dollars or as a percentage of salaries and wages)*	
Grants, contracts, and "pass through" to other entities	
Capital improvement projects *(e.g., buildings, roads, fences, etc.)*	
All other expenditures	
TOTAL	

3. How many full-time (FT) or full-time equivalent (FTE) natural resources management employees currently work in your organization in Hawai'i?

_____

4. Please identify the kinds of jobs in your organization that support your natural resources management work in Hawai'i. (Check all that apply)

- ☐ Scientist
- ☐ Field Technician
- ☐ Hunter
- ☐ Natural resource manager
- ☐ Cultural Practitioner
- ☐ Construction personnel
- ☐ GIS/data manager
- ☐ Technical information systems
- ☐ Bookkeeper
- ☐ Accountant
- ☐ Grants management
- ☐ Fundraiser
- ☐ Government policy
- ☐ Administrative support
- ☐ Communications and outreach
- ☐ Lawyer
- ☐ Planner
- ☐ Research/Analyst
- ☐ Training
- ☐ Lab technician
- ☐ Other (please describe)

5. What is the approximate average education level for the following categories of natural resources management employees in your organization in Hawai‘i? (check only one box in each row)

	No minimum	HS Diploma	2-year Associates	4-year Bachelors	Masters	PhD
Administrative						
Field/Technical						
Professional/Managerial						
Executive						

6. What is the approximate average starting salary for the following categories of natural resources management employees in your organization in Hawai‘i? (check only one box in each row)

	$20-40K	$41-50K	$51-60K	$61-80K	>$80K
Administrative					
Field/Technical					
Professional/Managerial					
Executive					

7. Does your organization currently offer natural resources management internships in Hawai‘i, i.e., paid or unpaid short term (1-6 mos.) educational opportunities? (check all that apply)

- Yes, we offer paid internships
- Yes, we offer unpaid internships
- No, we don’t offer internships
- Other (text box)

8. Does your organization currently offer natural resources management fellowships in Hawai‘i, i.e., paid or unpaid medium term (>6 mos.) professional development opportunities? (check all that apply)

- Yes, we offer paid fellowships
- Yes, we offer unpaid fellowships
- No, we don’t offer fellowships
- Other (text box)

9. Approximately how many full-time (FT) or full-time equivalent (FTE) natural resources management positions has your organization lost or gained in Hawai‘i in the last 3-5 years? You may express your

answer as a percentage or a number of positions, e.g., 15% loss or lost 3 jobs. Please specify loss or gain (+ or -) in your response.

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10. Approximately how many full-time (FT) or full-time equivalent (FTE) natural resources management positions does your organization expect to lose or gain in Hawai‘i in the next 3-5 years? You may express your answer as a percentage or a number of positions, e.g., 5% gain or gain 1 job. Please specify loss or gain (+ or -) in your response.

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