

# Outdoor-Industry Jobs



A Ground Level Look at Opportunities in the  
**Agriculture, Natural Resources, Environment,  
and Outdoor Recreation Sectors**

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## **A Ground Level Look at Opportunities in the Agriculture, Natural Resources, Environment, and Outdoor Recreation Sectors**

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## Executive Summary

Washington’s Workforce Training and Education Coordinating Board (Workforce Board) was tasked by the Legislature to conduct a comprehensive study<sup>1</sup> centered on outdoor and field-based employment<sup>2</sup> in Washington, which includes a wide range of jobs in the environment, agriculture, natural resources, and outdoor recreation sectors.

Certainly, outdoor jobs abound in Washington, with our state’s inspiring mountains and beaches, fertile and productive farmland, abundant natural resources, and highly valued natural environment. But the existing data does not provide a full picture of the demand for these jobs, nor the skills required to fill them.

*Understating often has the effect of undervaluing these jobs and skills, which can mean missed opportunities for Washington’s workers and employers.*

Digging deeper into existing data and surveying employers in these sectors could help pinpoint opportunities for Washington’s young people to enter these sectors and find fulfilling careers.

This study was intended to assess current—and projected—employment levels across these sectors with a particular focus on science, technology, engineering and math (STEM) oriented occupations that require “mid-level” education and skills. This education includes post-high school training but stops short of a bachelor’s degree,<sup>3</sup> opening the door to a greater number of students who are not focused exclusively on four-year degrees. The study was also designed to identify employer demand for occupations within these four sectors.

As required by the legislation, the Workforce Board convened a steering committee representing industry, labor, government, and education-related organizations to guide the work and recommendations put forth in this study (refer to **Appendix 1** for steering committee membership). The goal was to produce recommendations and next steps that help provide educators and counselors with detailed data that helps connect Washington students with training for these jobs in the area where they live, including identifying specific skills in demand.

The Workforce Board assessed available state and federal data on current and projected employment levels along with hiring demand for mid-skill workers in these sectors. Research staff also considered data produced by web-crawlers that pull from online job-postings to shed further light on skills and occupational demand across industries.

In addition, the Workforce Board contracted with Washington State University to conduct a series of interviews with 17 employers representing a cross-section of different industries to understand their workforce needs and expectations for growth. Although those findings are not statistically

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<sup>1</sup> WORKFORCE ASSESSMENT--AGRICULTURE, ENVIRONMENT, OUTDOOR RECREATION, AND NATURAL RESOURCES SECTORS, SECOND SUBSTITUTE SENATE BILL 5285, Chapter 182, Laws of 2017, 65th Legislature, 2017 Regular Session, EFFECTIVE DATE: 7/23/2017.

<sup>2</sup> The terms outdoor and field based employment are frequently used in this report to broadly describe the occupations and industries to be evaluated. The Steering Committee suggested these terms and they are useful in making this report more accessible.

<sup>3</sup> Skilled mid-level occupations are defined as those requiring more than a year of post-high school education and training, but less than a four-year degree.

representative of all Washington employers in the selected sectors, the results underscore broader workforce information challenges, as well as the skill-needs and industry trends within those sectors.

## Key Findings

Improving the accuracy, quality, and timeliness of available data will help align future investments in education and training with the ground-floor needs of industry, while helping build a workforce pipeline. Accurately capturing employer demand also helps keep these mid-level outdoor and field-based careers front and center when prioritizing federal, state, and local investments in workforce initiatives.

The Workforce Board finds that:

- Available state, federal, and online job-posting data sources alone are insufficient for conducting satisfactory region-specific demand assessments for field-based, mid-level, STEM occupations in agriculture, natural resources, environment, and outdoor recreation sectors.
- It is difficult to clearly define which occupations and employers should be classified within these sectors. That's because there is no common, agreed upon "taxonomy of occupations" in these sectors at either the federal or state level. The one exception is agriculture, which has an official federal industry classification, or NAICS code.<sup>4</sup>

Workforce trends, employment, and skill requirements gleaned from employer interviews and available data show:

- New hires with cross-functional skills, knowledge, abilities, and other competencies are increasingly sought after. Meanwhile, current employees are increasingly expanding their duties, taking on broader, cross-functional roles and responsibilities.
- Cross-functional technical skills and knowledge do not always reflect an employee's job title or official occupation as coded under the federal classification of occupations known as the Standard Occupational Classification (SOC) System.<sup>5</sup>
- Computer aided-manufacturing and automation are increasingly common within industries not historically associated with these technologies.
- Basic computer literacy and software skills, such as email, word processing, and spreadsheet proficiencies, are broadly essential work place skills.

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<sup>4</sup> The North American Industry Classification System (NAICS) is the standard used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. Washington's state agencies also use this federal standard.

<sup>5</sup> The Standard Occupational Classification (SOC) system is a federal statistical standard used by federal agencies to classify workers into occupational categories for the purpose of collecting, calculating, and disseminating data. All workers are classified into one of 860-plus detailed occupations according to their occupational definition.

- Employers struggle to find workers with core competencies in communication, teamwork, integrated systems thinking, problem-solving, self-initiation, honesty, and integrity.
- Attrition is increasing as aging workers opt to leave outdoor and field-based industries for other opportunities, or retire.

## Recommendations

1. **Develop a standard methodology to define sectors.** The state needs to define exactly what types of economic activity fall within each of the four sectors in this study. Currently, only the agriculture sector is clearly defined in the federal industry classification NAICS coding structure: the other sectors do not exist as high-level NAICS industry groupings.

**Note:** NAICS codes are more fully explored later in this report. Generally speaking, they are a 2- to 6-digit classification system, with five levels of detail. The more digits included in the code, the more fine-grained the detail.

The state needs to identify which industries should be included in new definitions, based on detailed “sub-industry” NAICS codes. This is a significant task. It first means establishing official criteria for what constitutes, for example, the ‘environment sector.’ It would then require sorting through many industries, at the most detailed level of coding, to evaluate and assign them so that they “stack up” into these newly defined “composite” sectors that pull pieces from a wide range of industries.

This poses another challenge in that many industries at the most detailed level lack a crosswalk to occupation counts. This makes it impossible to accurately assess the occupational demand of these composite sectors—in other words, what the hiring demand is for different jobs within each newly created sector. Only at higher level industry groupings already defined by NAICS do such cross-walks exist. However, at this higher level, it is often not possible to tease out occupation counts that fall within “alternatively defined” composite sectors built from the most detailed industry level on up.

**Capture occupation-level data.** Preparing students for job opportunities requires a deeper, more accurate understanding of demand by occupation and skill set. But to get at these details, we need a system that captures more information and is more flexible to assess demand among changing industries and sectors. This report identifies four approaches to address this issue:

- i. Work with Washington’s employers to collect occupation-level data. One way to do this is to have employers provide occupation data when they submit reports of individual employment to the state’s Unemployment Insurance system. Currently, employers do not provide this level of detail. Instead, under federal contract, Washington surveys employers to better estimate occupational demand within industries. The limited size of this sample imposes serious constraints on the accuracy and regional specificity about job opportunities within industries— especially for sectors not defined in the current NAICS system. Should employers begin providing additional information about employee occupations, the data would need to be protected with the same robust safeguards currently used for data collected for UI purposes.

- ii. Expand use of web-crawler services that aggregate online job-postings. This will help supplement existing data by providing a real-time look at what employers are seeking in the way of in-demand skills by occupation across different industries and regions.
- iii. Conduct surveys, focus groups, and interviews. This helps provide a better understanding of which occupations employers are hiring for and the specific skills they need to better fill these positions. This also will help better anticipate future employment and skills demand. Job-titles and occupations are constantly shifting, with workers taking on additional roles and responsibilities beyond the scope of what is defined in the federal Standard Occupational Classification system. Moreover, jobs requiring similar skill sets can have different titles between industries, further complicating this issue.
- iv. Establish a “sentinel network” for strategic sectors of interest, similar to Washington’s Health Workforce Sentinel Network. Such networks of employers can provide real-time information on emerging trends in Washington labor markets.<sup>6</sup> By creating Networks for other sectors, the state would quickly gather ground-level feedback from a wide range of outdoor and field-based employers, helping students get up-to-date information on job opportunities and a better understanding of the skills they need to succeed in these jobs.

2. **Establish clear guidelines on how data is used to make workforce policy and program decisions.** Currently available employment and occupational demand data alone is insufficient, particularly when making regional decisions. This is especially true for newly created “composite” industries, such as those in this report, that are not currently federally defined. Policy-making and program decisions should be considered with multiple stakeholders and data sources in mind. Analyses should be based on a variety of complementary data sources, both quantitative and qualitative. Programs designed to inform and prepare students and workers for career opportunities should be aligned with the needs and practices of local employers.

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<sup>6</sup> Workforce Training and Education Coordinating Board, “Washington State Health Workforce Sentinel Network”. <http://www.wtb.wa.gov/HealthSentinel/>

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## Purpose

Careers in agriculture, environment, natural resources, and outdoor recreation sectors can offer rewarding paths for students interested in the natural world and field-based opportunities. The U.S. Department of Agriculture projects employment opportunities in some of these sectors will grow.<sup>7</sup> Washington’s Legislature also is confident about these career paths and tasked the Workforce Board earlier this year with conducting a comprehensive study centered on outdoor and field-based employment in Washington.

However, many Washington students are either unaware of such opportunities or do not have access to information and resources that could help them make an informed decision to prepare for these career options. Research contained in this report is intended to provide policymakers, program managers, and educators with an overview of existing data and information resources, along with the limitations of those resources. Ultimately, educators and counselors need more detailed data about field-based jobs to better help Washington students connect with outdoor and field-based career opportunities.

*The goal of this report to produce recommendations that help educators and counselors receive the detailed data they need to connect Washington students with field-based jobs, including identifying specific skills needed for these jobs.*

The Workforce Board was tasked to evaluate available state and federal data on current and projected employment levels, and hiring demand, for skilled mid-level workers in the state’s four field-based economic sectors. Some marketable skills in these sectors require the ability to identify, apply, and integrate concepts from science, technology, engineering and math (STEM) – and are a strong qualification for securing a living-wage job. Moreover, these skills are often transferrable to well-paying occupations in industries outside of those sectors as well.

## Methodological Approach

For the purposes of this report, skilled mid-level occupations are defined as those requiring more than a year of post-high school education training, but less than a four-year college degree. However, it was believed at the study design stage that “existing workforce data” does not adequately describe the number or characteristics of mid-level jobs in each of the four sectors, with the possible exception of agriculture. With these limitations in mind, Workforce Board research staff attempted to pull all the possible available data together. In the process, research staff validated the underlying assumption that current data resources are insufficient, as this report will show.

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<sup>7</sup> U.S. Department of Agriculture (USDA), “Employment Opportunities for College Graduates in Food, Agriculture, Renewable Natural Resources, and the Environment – United States, 2015-2020”. Summary, 2015, <https://www.purdue.edu/usda/employment/wp-content/uploads/2015/04/2-Page-USDA-Employ.pdf>

## Limitations of Publicly Available Data and Alternatively Defined “Composite” Sectors

Existing data available through the state’s Employment Security Department, the U.S. Department of Labor, and the U.S. Census Bureau does not provide accurate estimates on the specific skills needed to be employed in field-based, STEM-related occupations within the industry sectors in question, nor does it accurately estimate the demand for specific occupations within those sectors. This is not necessarily a weakness; rather, these systems were not designed to answer the specific, fine-grained questions about occupational demand in agriculture, natural resources, environment, and outdoor recreation.

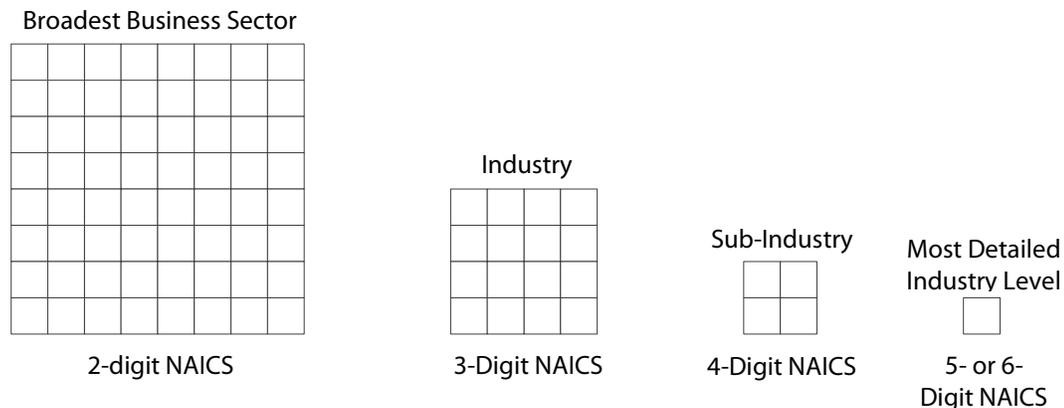
Industry and sector profiles can be examined in terms of firm counts, employment counts, (including employment counts by occupation), along with average wages using the North American Industrial Classification System (NAICS).<sup>8</sup>

### What are NAICS codes?

This report will often refer to NAICS codes. They are a 2- to 6-digit classification system, with five levels of detail. The more digits included in the code, the more fine-grained the detail (refer to **Exhibit 1**: for an illustration of the NAICS structure)

### **Exhibit 1: Illustration of the NAICS Structure**

The North American Industry Classification System (NAICS) is the official taxonomy that businesses are classified under according to the type of industry activity they are engaged in.



For example:

### **Manufacturing Sector (2-digits)**

- Wood Product Manufacturing Industry (3-Digit)
  - Sawmills and Wood Preservation Sub-Industry (4-digit)
    - Sawmills (5- or 6-digit)

**Note: This illustration does not represent the entire universe of industries a sector is composed of. Sectors can contain hundreds of industries at the most detailed industry level.**

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<sup>8</sup> The North American Industry Classification System (NAICS) is the standard used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. Washington’s state agencies also use this federal standard.

Natural resources,<sup>9</sup> environment, and outdoor recreation are not federally recognized sectors using NAICS codes. In this report, Workforce Board research staff attempted to create, in essence, new alternative “composite” sectors to better reflect the needs of Washington’s employers and those interested in these careers. These newly created composite sectors also mirror the Legislature’s intent in creating this report and align with the Steering Committee’s views. However, the Workforce Board lacks the authority to define what these sectors look like at an official level.

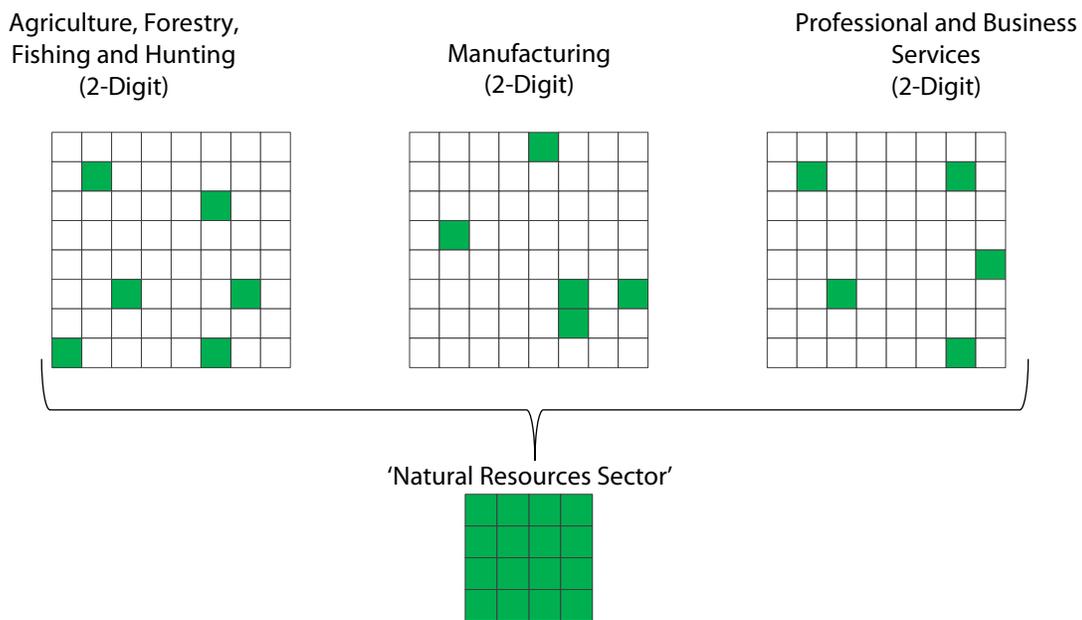
### Defining Composite Sectors

Businesses are organized around NAICS in terms of their economic activity. Without clearly defined six-digit NAICS codes it’s difficult to explain the type of work an organization does—and by extension, what skills fulfill those specific industry needs.

For clearly defined “sub-industries,” it’s sometimes possible to reach conclusions about needed skills. For example, with the Forestry and Logging sub-industry, there is clearly an ‘outdoor’ skills-related component. On the other hand, Engineering Services within the Environmental sector is more ambiguous. Only at the 6-digit (most detailed) NAICS level, can more specific details on the nature of an organization’s work be understood. A crosswalk between industries and occupations does not exist at any level of detail below 4-digit NAICS.

Therefore, it is necessary to construct alternative composite sectors, such as the ‘Natural Resources Sector’, from the NAICS at the 5- or 6-digit level. Composite sectors should be grouped at the highest detail possible in order to accurately reflect how the composite sector is defined. A standardized, methodological approach is needed for defining legitimate composite sectors intended to be used in an official capacity (refer to **Exhibit 2**: for an example of how a composite sector is constructed).

### **Exhibit 2: Example of a ‘Composite Sector’**



<sup>9</sup> Natural resources as understood by the intent of Legislative bill S5285 (which led to this report) differs from the official definitions of natural resources as defined by NAICS.

### Issues with Sector Definitions

Natural resources would typically be considered an extractive industry sector. For this report, the forestry and logging industry is considered part of the natural resources sector. The product in the case of forestry and logging<sup>10</sup> is felled trees and support for tree felling operations. This is captured at the 3-digit, even 4-digit NAICS level under agriculture, where occupational inference is possible. However, this does not always work. As forestry is an important sector in Washington, suppose it was desirable to expand this definition of natural resources to include saw mills, which are a manufacturing activity. This kind of sector synthesis then becomes difficult because saw mills are coded at a 6-digit level, where occupational inference is not possible with current resources.

Another set of issues arises if incorporating wood product manufacturing at the 3-digit level because it would also capture everything below 3-digits. In this case, it would include mobile home manufacturing, which is far different from what is typically considered 'natural resources.' There are even issues at a 4-digit level. This level is more precise but is potentially still too inclusive in some cases, such as with "Saw Mills and Wood Preservation", where wood preservation – which involves chemical treatment and derivative wood products – is perhaps too processed to be considered natural resources. The question then arises, at what point in the value chain do we differentiate sectors?

### Limitations of the Industry-Occupation Crosswalk

As mentioned previously, a lack of occupation-level data hampers our ability to accurately assess demand for jobs within the agriculture, environment, natural resources and outdoor recreation sectors. This is a hurdle not just for the newly defined field-based sectors used in this report, but also for existing, official economic sectors. The primary source of industry data is unemployment insurance (UI) data. Currently, Washington employers do not report this data when making their Unemployment Insurance payments, as is true in the vast majority of U.S. states.

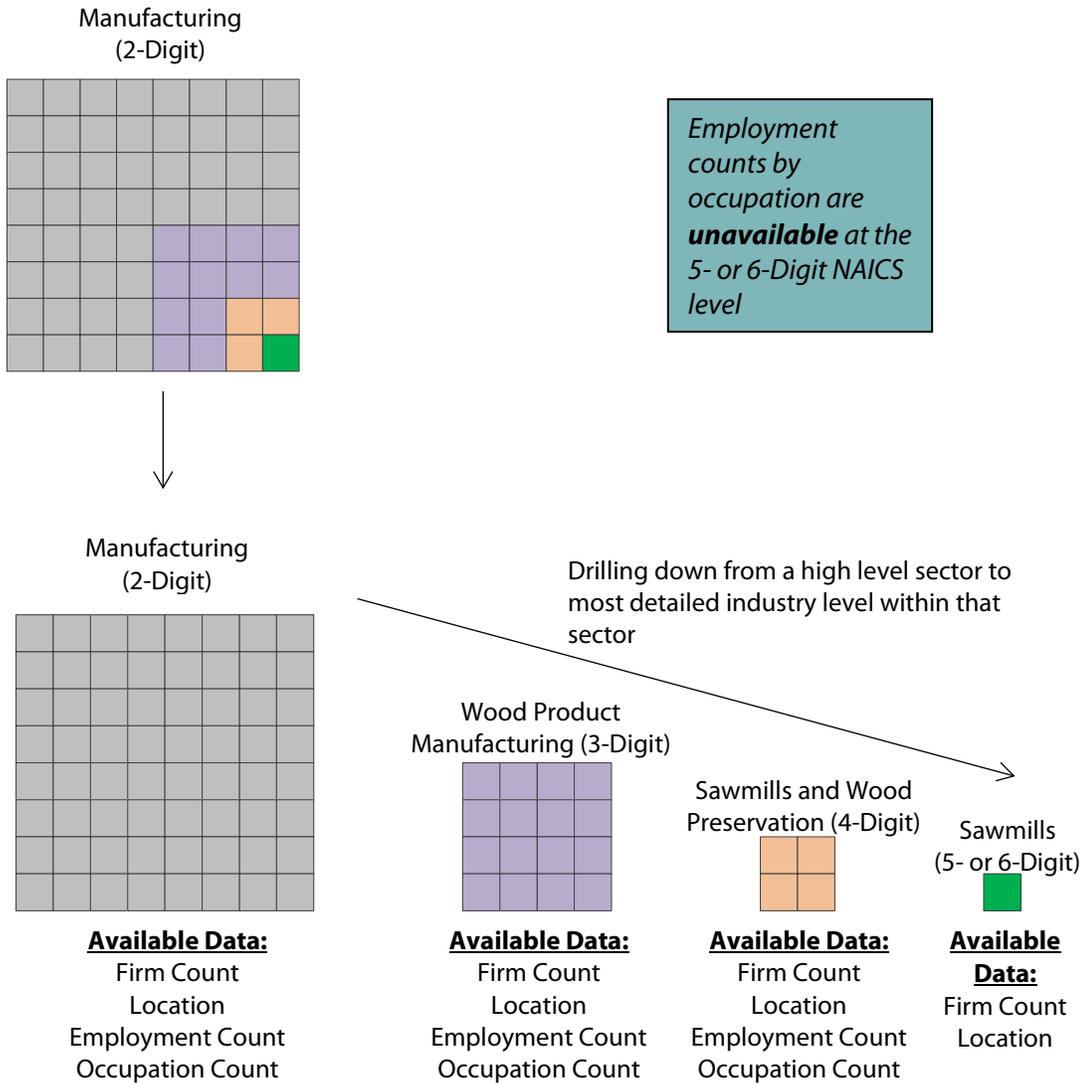
As a workaround, Washington's Employment Security Department periodically surveys employers to better estimate occupational demand within industries. These surveys are used to develop crosswalks for specific industries at the 2-, 3-, and 4-digit NAICS level. This is why resolution at the most detailed industry level, 6-digit NAICS, simply isn't possible using UI data. Nor are occupational surveys sufficient for creating a crosswalk between estimated occupational demand within the "composite" sectors used in this report. This is the same problem in drilling down to specific regions or industries, even within federally defined industry sectors. This problem at getting at key details makes it difficult to provide students, or existing workers, with accurate information about which jobs within specific industries are hiring, or where growth is particularly strong, or lagging (refer to **Exhibit 3**: for an illustration of what data is available per NAICS level).

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<sup>10</sup> It should be noted that forestry and logging are classified under the agriculture sector in NAICS, but for the purposes of this report is also grouped into natural resources.

### Exhibit 3: Example of What Data is Available per NAICS Digit

Drilling down to the most detailed industry level:



#### **Data does allow for some context**

Despite being unable to resolve occupational data at the most detailed industry level, such as specific occupations within sub-industry groups at a county level, the data does provide some context as to the number of workers these sectors employ within different geographic areas. Doing this requires using looser definitions of which industries fall into a composite sector, and what some of the most common occupations are within these sectors and geographic areas based on data from the U.S. Bureau of Labor Statistics, and through estimates arrived at through the American Community Survey under the U.S. Census Bureau. It is possible to map – at a high level – the relative employment intensity, or how prevalent certain industries, such as agriculture and natural resources, are within a particular region. Known as a “location quotient” it’s a way of quantifying how concentrated a particular industry is within a region, when compared to other regions, or even the nation. So in Washington, for example, the state’s location quotient for aerospace is extremely high compared to other states. However,

for the purposes of this report, location quotient only applies to regions within Washington in relationship to each other.

Unfortunately, a definition of what constitutes the environment and outdoor recreation sectors are either too broad, or too narrow, to be meaningful at a 4-digit level, and is impossible at a 6-digit level. Therefore, this report is only able to present location quotients for agriculture (including food manufacturing) and natural resources (defined as extractive and extraction support industries only).

### **Self Employed, Contract Workers, and Tribal Businesses**

Employment counts and other industry-sector data may still be underrepresented because self-employed and contract employment is not captured in the data provided by the state's Employment Security Department (ESD).

Although tribal businesses *do* report their covered employment and wages quarterly to the state, their data are classified as local government. The Quarterly Census of Employment and Wages (QCEW) unit at ESD produces a detailed quarterly file that may also contain an indicator for tribal employers, but would require a data sharing agreement to use and publish.

### **Other Limitations:**

Employment counts do not account for the aging workforce. This "silver tsunami" is expected to hit the agriculture and natural resource sectors especially hard over the next 10 to 15 years.

#### *Alternative Data Sources: Online Job-posting Aggregators*

As an alternative to publicly available data, the Workforce Board analyzed skill requirements from online job-postings for mid-level, field-based job-postings focused on STEM. These job-postings were collected from Burning Glass,<sup>11</sup> de-duplicated, and aggregated into the 'Burning Glass' database, which provided filtering options to isolate industry sectors, sub-sectors, locations, occupations, job titles, and skills clusters while maintaining options to drill down to firm-specific job openings.

Although this data set is useful for teasing out a general sense of industry demand for specific occupations and skills, it is not necessarily comprehensive. For example, many job openings in smaller firms, or in niche occupations, may not be advertised online, and are therefore not recorded by online aggregators. Nor does this data set account for "churn," in which workers within an industry switch between firms. Job-postings alone are not enough to arrive at actual labor demand. Nonetheless, online job-postings can be helpful in identifying key skill clusters, pay, and location.

### **Firm-specific Data**

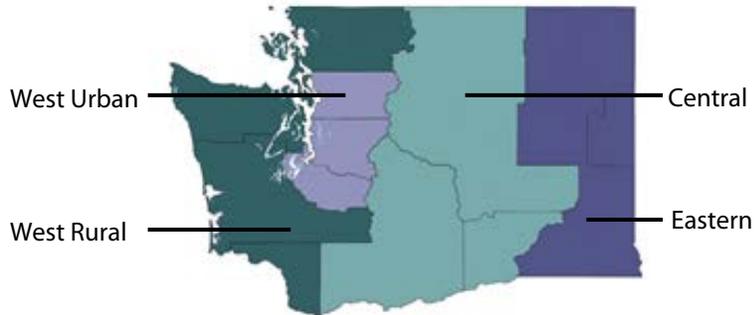
Information was collected directly from 17 Washington employers with operations in each of the four industry sectors that are the subject of this report. These employers are located in urban and rural communities across the state, and include large-, medium- and small-sized employers – including private and public-sector organizations – with a workforce that is employed in a range of technical, field-based, STEM-oriented occupations (refer to **Exhibit 1: Economic Development Areas of**

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<sup>11</sup> Burning Glass Technologies is an analytics software company that provides real-time data on job growth, skills in demand, and labor market trends.

**Washington** for a map of the participating organizations, the industry sectors they represent, and the geographic distribution of employment across the state). The occupations of interest are limited to technically oriented jobs that do not require a four-year college degree at entry, that is, skilled “mid-level” technical jobs.

**Exhibit 1: Economic Development Areas of Washington<sup>12</sup>**



The next step was to identify and secure participation by the selected sample of employers from identified industry sectors and regions (refer to **Table 2: Industry Sectors, Regions and Employers**).

**Table 2: Industry Sectors, Regions and Employers (Washington Employment)<sup>13</sup>**

Sector	Region			
	West Rural	West Urban	Central	Eastern
<b>Agriculture</b>	Ocean Spray (130)	Darigold (1,060)	Tieton Cider (20), and JR Simplot (1,650)	McGregor Company (271)
<b>Natural Resources</b>	Sierra Pacific (871)	Weyerhaeuser (1,800)	Yakama Nation (1,100)	Vaagen Brothers (217)
<b>Environment</b>	Quinault Nation (700)	Tacoma Power (1,400)	Grant Public Utility District (590)	County of Spokane (1,934)
<b>Outdoor Recreation</b>	Summit at Snoqualmie (1,450) <sup>14</sup>	Cascade Designs (315)	Red's Fly Shop (12)	Renaissance Marine Inc. (127)

*Selected Sample of Employers from Identified Industry Sectors and Regions, Total Employment in Washington: 13,647<sup>15</sup>*

Employers were invited to participate in the study and were briefed on the time and data collection requirements. Employers who agreed to participate later provided employment-related data. Human resources staff and technical managers were then engaged in telephone interviews with members of

12 The Workforce Board’s research team identified geographic regions based upon existing regional designations used by the 12 Workforce Development Areas (WDAs). WDAs are also the basis for the state’s 12 economic areas identified by the Pacific Northwest Regional Economic Analysis Project (PNREAP), (<https://washington.reaproject.org/>), (Figure 1). This design helped align the selection and analysis of existing data sources with the 12 WDAs. Next, the research team consolidated the 12 WDAs into four (4) aggregate regional areas for the purposes of employer selection, sector diversity, rural/urban mix, and geographical representation.

13 Washington employment estimates are based on reports from employers provided during the data collection period of February-September, 2018. Estimates do not include outside contracted employment.

14 The majority of these positions are seasonal part-time hires.

15 Total employment estimate is based on reports from employers during the data collection period of February-September, 2018. Estimates do not include outside contracted employment.

the research team. All employers were assured their company data would be reported at aggregate levels only, and that the data would not be attributed directly to them without their permission.

Researchers asked each employer to identify all technically skilled mid-level jobs tied directly to the primary product or services created and marketed by the organization. For each identified job, employers were asked to provide data on hiring levels, job vacancies, and to estimate future (three-year) job growth and retirement trends.

Telephone interviews with human resources managers or executives were conducted to review and verify the numerical data, and to collect more information about industry and company trends, total employment and other topics. Employers were also asked to identify up to three (3) of the jobs they regarded as especially high priorities for hiring, retention and/or replacement in the future. For those jobs, one or more additional phone interview of up to 90 minutes was conducted with managers or other subject matter experts about each job. These extensive interviews, which focused on each high-priority job, enabled researchers to collect information on:

- Why each job was identified as a high-priority.
- Job-specific information about the knowledge, technical skills, and requirements for employment.
- Related career pathways at that organization.

## **Limitations of Firm-specific Data**

A key research goal was to identify the types and characteristics of specific mid-level technical jobs. The research design included a limited sample of 17 employers across four industry sectors. The limited number of employers and selection methods represents a sample of convenience, which means that the findings cannot reliably represent or forecast employment or related factors for the state's industry sectors or employers as a whole.

Even if these interviews provided a statistically representative sampling of employers, which included employment counts and new hire counts for specific occupations – it would still be impossible to estimate occupational demand. For this to be possible, the data would also need to include attrition rates and be representative of the entire state economy.<sup>16</sup>

A primary focus of employer data collection and interviews was to characterize and document the range of employment in skilled mid-level occupations. Researchers sought to understand employer perspectives about the knowledge, skills and abilities they expect of employees in a select number of key occupations, at a deeper level than is available using standard labor market information. This information is especially valuable because it is current, qualitatively rich, provided directly by Washington employers in urban and rural sites and communities across the state, and is specific to mid-level occupations and trends in the four targeted industry sectors.

Some employers offer employment in multiple sector categories, and functional overlap exists among the types of skilled mid-level jobs they provide. To simplify and organize the collection and analyses of mid-level jobs in each of the targeted sectors, employers were assigned to only one industry sector.

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<sup>16</sup> The reason is that estimates for assessing occupational demand must also include job churn where employees move between employers and even between industries. For example, if two mechanics leave their employer and essentially switch – the data would reflect two openings for mechanics even though there was no net change in the number of mechanics employed. Without accounting for attrition and churn, any attempt to assess occupational demand based on job-openings alone would result in an over estimation of occupational demand.

This helped ensure that a diverse range of employment and job types were included in each sector, and prevented potential duplication of data. Data requests and interviews focused on mid-level jobs that best represented employment and job functions related to that sector. Some numerical data presented in the main body of the report represents a portion of an employer's job base (but not total employment), as some employers provided employment data and interviews for job types from a specific business unit only.

## Findings

### Agriculture Sector

#### Industry Description

Rich soils, vast farmlands, diverse climates and large-scale irrigation make Washington one of the most productive growing regions in the world, which enables farmers to produce over 300 crops each year.<sup>17</sup> The state's deep-water ports and proximity to important Asian markets also provide natural advantages for agricultural trade. In 2016, the value of Washington's agricultural production totaled \$10.6 billion.<sup>18</sup> The structure of the agriculture sector is also diverse, representing the full range of agricultural products – from myriad crops to livestock products, timber, fishing and by extension, certain types of manufacturing (although manufacturing is not typically considered part of the agriculture sector as per the NAICS taxonomy). Agriculture also entails an abundance of large-scale production cycles: growing, harvesting, processing, packaging, storage and transportation – all of which provide significant employment opportunities in rural and urban areas across the state.

For the purposes of this study the agriculture sector is comprised of standard agriculture, plus food manufacturing.<sup>19</sup> This includes sub-industries like crop production, animal production, forestry & logging, fishing, along with food manufacturing (this excludes beverage manufacturing, which would also include large industries such as brewing). Combined, these industries employed over 141,000 workers in 2016, with total wages of nearly \$5 billion. These employment and earnings figures have progressively risen since 2014 (refer to **Table 3: Agriculture and Food Manufacturing Sector Snapshot**).

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<sup>17</sup> Agriculture: A Cornerstone of Washington's Economy. Washington State Department of Agriculture, March 29, 2018: <https://agr.wa.gov/aginwa/default.aspx>

<sup>18</sup> U.S. Department of Agriculture, Press Release, National Agricultural Statistics Service, October 13, 2017: [https://agr.wa.gov/aginwa/docs/Top10WA\\_2016.pdf](https://agr.wa.gov/aginwa/docs/Top10WA_2016.pdf)

<sup>19</sup> Data on timber/forestry/logging provided by employers in this sector was not collected, only in the natural resources sector. Similarly, 'fish' related industries were not included the environment sector interviews with employers.

**Table 3: Agriculture and Food Manufacturing Sector Snapshot***Washington State, 2014-2016 Annual Averages*

Year	Average Firm Count	Average Annual Employment	Total Wages Paid	Average Annual Wage	Average Weekly Wage
2014	8,199	135,839	\$4,346,940,832	\$32,001	\$1,375
2015	8,295	138,842	\$4,522,082,462	\$32,570	\$1,399
2016	8,271	141,890	\$4,829,106,343	\$34,034	\$1,741

**\*Note:** Average weekly wages may appear proportionately larger than average annual wages. This is likely because of the seasonal nature of agricultural work.

**Source:** Washington State Employment Security Department, QCEW Annual Averages

The biggest employers on average were fruit and other crop growing and harvesting, followed by seafood and frozen fruit manufacturing, preparation and packaging. These industries accounted for 52 percent of agriculture sector employment in 2016. While the sector employs a large number of people, the pay is fairly low at \$34,034 a year, which is nominally considered a living wage. Many of the jobs driving down the average pay rate would not be considered skilled mid-level jobs, such as fruit pickers (refer to **Table 4: Agriculture Sub-industry Breakout**).

**Table 4: Agriculture Sub-industry Breakout***Washington State, 2016 Annual Averages*

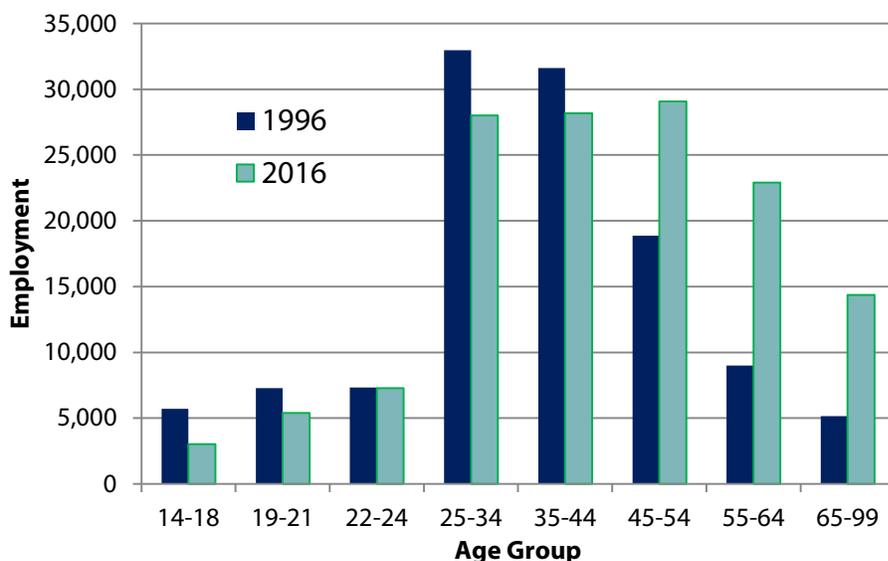
Sub-Industry	Avg. firms	Total 2016 wages paid	Average annual employment	Average annual wage	Share of Total Employment	Share of Agriculture Sector Employment
Crop production	5,116	\$1,821,470,708	69,713	\$26,128	2.2%	49.1%
Animal production	836	\$238,302,107	6,933	\$34,372	0.2%	4.9%
Forestry and logging	454	\$274,299,337	3,876	\$70,769	0.1%	2.7%
Fishing, hunting and trapping	230	\$124,406,921	1,477	\$84,229	0.0%	1.0%
Agriculture & forestry support	700	\$678,606,570	22,702	\$29,892	0.7%	16.0%
Food manufacturing	936	\$1,692,020,700	37,190	\$45,497	1.2%	26.2%
<b>All Agriculture</b>	<b>8,272</b>	<b>\$4,829,106,343</b>	<b>141,891</b>	<b>\$34,034</b>	<b>4.4%</b>	<b>100.0%</b>

**Source:** Washington State Employment Security Department, QCEW Annual Average

When compared to overall employment, agriculture and food processing have a larger share of younger workers. However, over the last 20 years, the sector's workforce has aged; in 1996 the 25-34 year-old cohort was the largest age group, whereas by 2016 the 45-54 year-old cohort was largest (refer to **Chart 1: Changing Age Patterns in Agricultural Employment**).

**Chart 1: Changing Age Patterns in Agricultural Employment**

*Washington State, 2006 & 2016*



Source: U.S. Census, LEHD

The most common skilled mid-level occupations in the agricultural sector, plus food manufacturing, leans heavily toward the Central Washington region in absolute employment numbers – and does indicate the presence of STEM-related occupational fields such as mechanics, electricians, and food science technicians (refer to **Table 5: Top Mid-level Occupations in Agriculture by Area**).

**Table 5: Top Mid-level Occupations in Agriculture by Area<sup>20</sup>**

Occupation	Estimated Mid-level Employment in Agriculture				
	Statewide totals	Regions			
		West Rural	West Urban	Central	East
Heavy and Tractor-Trailer Truck Drivers	1,186	222	374	297	303
Industrial Machinery Mechanics	1,086	237	265	545	42
Bookkeeping, Accounting, and Auditing Clerks	1,067	152	328	475	129
Maintenance and Repair Workers, General	929	210	273	388	62
Farmers, Ranchers, and Other Agricultural Managers	615	86	33	348	172
Farm Equipment Mechanics and Service Technicians	552	67	16	400	69
Agricultural and Food Science Technicians	135	52	2	64	17
Electricians	63	15	13	31	4
Human Resources Assistants	51	18	9	23	1
Transportation, Storage, and Distribution Managers	43	7	25	9	2
Water and Wastewater Treatment Plant Operators	23	15	8	0	0

<sup>20</sup> West urban includes: Pierce, King, and Snohomish counties. West rural includes: Clark, Cowlitz, Wahkiakum, Pacific, Lewis, Thurston, Grays Harbor, Mason, Kitsap, Jefferson, Clallam, Island, Skagit and Whatcom counties. Eastern includes: Asotin, Garfield, Columbia, Walla Walla, Whitman, Spokane, Pend Oreille, Stevens and Ferry counties. The central region includes all counties not mentioned in other areas.

Bus, Truck Mechanics, & Diesel Engine Specialists	21	6	5	3	7
Commercial Divers	16	16	0	0	0
Forest and Conservation Technicians	15	15	0	0	0
Captains, Mates, and Pilots of Water Vessels	11	11	0	0	0
Machinists	10	4	6	0	0
Millwrights	10	0	0	10	0
HVAC Mechanics and Installers	6	0	0	6	0
<b>Total</b>	<b>5,727</b>	<b>1,066</b>	<b>1,338</b>	<b>2,580</b>	<b>801</b>

*Source: Constructed table based on the Employment Security Department's 'Industry-Occupation Matrix'*

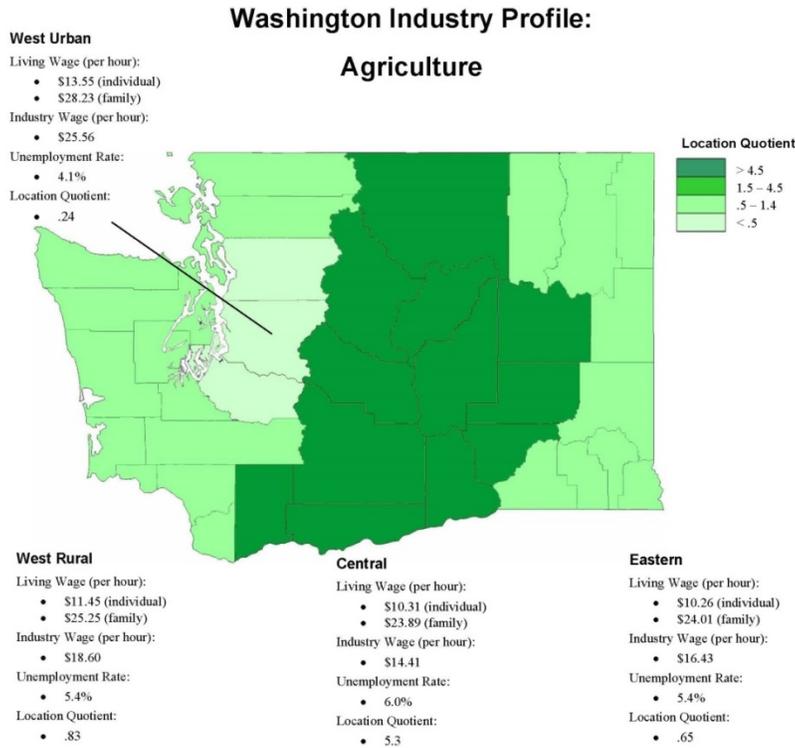
In the Western-urban area, truck drivers are the most common mid-level occupation in agriculture. However, comparisons by occupations across regions should be viewed within the context of the region. Because the Western-urban region accounts for over half of the state's employment, it is unfair to directly compare, truck drivers, for example, in Western-urban to truck drivers in the Eastern region. To account for this, a location quotient (LQ) that compares the share of a given occupation for the sector within a region against the share of that occupation at the sector state-level provides a more meaningful benchmark. Truck drivers in Western-urban have an LQ of 1.36, which indicates that within the agriculture sector, truck drivers account for a 36 percent higher share in the Western-urban region compared to the state.

The highest LQs at 5.22, meaning a share of more than five times higher than the statewide share, were found in the Western-rural region for:

- Captains/mates of water vessels, commercial drivers.
- Forest and conservation technicians.
- Installer/repairers of radio/cellular/tower equipment.

This provides a clear and measurable indication of differences in occupational composition within sectors across different regions of the state (refer to **Exhibit 2: Washington Industry Profile – Agriculture** for an overall view of the agriculture sector LQ across the state).

## Exhibit 2: Washington Industry Profile – Agriculture



**Source: Washington State Employment Security Department**

### Employer Interviews: Industry Trends

Like all industries, agriculture has adopted many new technologies, systems and operating principles. These innovations have helped to improve efficiency, productivity and the economic health of the more than 8,200 firms that operate in the state.<sup>21</sup> While innovations have occurred in virtually all agricultural sectors, the technological trend toward automation – the computerization of manufacturing and processing systems – is pervasive; employers report that automation continues to shape the skills and abilities required of individuals working in mid-level occupations across the agricultural sector. This will require an increasing number of individuals working as millwrights, mechanics and electricians to have a comprehensive understanding of entire mechanical and electrical systems, and how those systems interact with specific technologies such as Programmable Logic Controllers (PLCs).

This will require an increasing number of individuals working as millwrights, mechanics, and electricians to have a comprehensive understanding of entire mechanical and electrical systems.

The application of PLCs is not new, but ongoing advancements in technology have accelerated the employment and technical skill needs in this sector in several ways. As one processing operations manager noted: “It is difficult to find individuals with the skillset to work on automated machinery.” Automation is common in many other industry sectors (manufacturing, warehousing and transportation). Individuals with technical skills are likely to have several employment options to choose from.

<sup>21</sup> ESD/QCEW

Automation-related work is also crossing traditional occupational lines. As one processing operations manager noted, the need for mechanics to be cross-trained in both mechanical and electrical systems is increasing: “Everyone is looking for a mechanic that can also do basic electrical work.” Another manager noted that as a consequence of the trend toward computerized automation, the electro-mechanical work required in most mechanical and maintenance-related occupations can no longer be viewed independently from electrical work and will require even greater knowledge of computer applications: “Eventually mechanics will be called technicians.”

Automation-related work is also crossing traditional occupational lines. Eventually mechanics will be called technicians.

One specific example of the technological trend toward automation in the agricultural industry is the essential role that PLCs play for predictive maintenance. Using ladder logic (programming language for PLCs), workers program computers to survey and detect the status of mechanical and electrical functioning. This capacity allows mechanics and electricians to monitor a whole plant simultaneously and gives them the opportunity to use predictive maintenance to locate and repair equipment before it breaks. This requires a comprehensive understanding of mechanical and electrical systems, as well as computer systems. As a result, agricultural employers are increasingly looking for multi-skilled, mid-level employees. Indeed, employers noted that this suite of skills is becoming especially difficult for them to find. One company reported lowering their formal education requirements for electricians from a Master’s Electrician License down to an ELO1 (first-level electrician’s license) to broaden the applicant pool. Doing so has allowed them to attract other electricians who may have this broader skill set or who can readily be trained.

## Employment, Occupations and Requirements

The five agriculture sector employers who participated (Ocean Spray, Darigold, Tieton Cider, JR Simplot, McGregor Company) provided information on the full range of mid-level, technically oriented occupations, following the criteria provided by the research team that defined mid-level occupations used in this study.<sup>22</sup> These employers identified a total of 46 different job titles that met the definition at the sites they were reporting. Total employment (headcount) in those occupations was 391 (refer to **Appendix 2:** for the full list of occupations and employment-related data collected from).<sup>23</sup>

## High-Priority Occupations

Employers were also asked to identify up to three (3) occupations they regarded as a high priority for employment. High-priority jobs were generally defined as occupations that are currently hard to fill due to lack of qualified applicants, skill gaps among existing employees, or because of anticipated future hiring or retirements. Some of these job titles are generic (“production supervisor”) while others are uniquely named and specific to individual employers, but may represent many of the functions or duties of differently named job titles used by other employers.<sup>24</sup>

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<sup>22</sup> For this study, employers were asked to report technically oriented jobs that are directly tied to the primary product or services that are created and marketed by the organization, and for which the equivalent of a high school diploma (minimum) but less than a four-year college degree is generally a requirement for those jobs.

<sup>23</sup> As noted earlier, these numerical data are limited to the occupations identified by participating employers, and are primarily provided for identification and illustration. These data cannot be generalized to represent the industry as a whole.

<sup>24</sup> Because the project included large and small employers, and not all employers use the same job titles for similar jobs, the number of some common job titles may vary considerably compared to others.

## High-Priority Agriculture Jobs, Employment and Projections

Many of the 15 occupations identified by employers relate to mechanical and maintenance, followed by technical supervisory positions (refer to **Table 6: Job Titles and Related Employment Information Provided by Employers in Agriculture** for job titles and related employment information provided by employers). Only a few of these jobs were reported as having large numbers of vacancies, projected new hiring or retirements. This was more typical for service technician, service manager, line mechanics production technicians and process mechanics than for other occupations in this group. It is important to note that a primary reason that employers identified these jobs as high priority was because they are critical to ensuring that production operations, including product quality, are not jeopardized; many of the positions identified are aimed at either preventing production disruptions (maintenance) or responding to production incidents (repair) that may impede output and product quality. Similarly, while the numbers provided by some employers were smaller than others, these positions were regarded as essential while no less important than those with more vacancies, anticipated hiring or retirements. Indeed, in smaller companies with fewer employees, the lack of qualified skilled workers can be especially challenging because they may rely on a single employee to perform several critical jobs.

**Table 6: Job Titles and Related Employment Information Provided by Employers in Agriculture**

Job Title	Employment	Job Vacancies	New Hiring, Next 3 Years	Retirements, Next 3 Years
Maintenance Engineer	93	4	33	3
Service Technician	87	11	8	10
Production Supervisor	36	3	3	1
Service Manager	22	0	7	7
Process Mechanic	19	0	6	6
Boiler Maintenance Mechanic	8	0	3	3
Electrician	7	0	1	1
Seed Mill/Warehouse Tech	5	2	2	2
Electro Mechanic	5	1	1	0
Production Tech	4	1	5	0
Electro Mechanic A	3	1	1	0
Cider Maker	1	1	0	0
Lab Technologist	1	0	1	0
Maintenance Electrician	1	1	1	0
Mechanic	1	0	1	0
<b>TOTAL</b>	<b>293</b>	<b>25</b>	<b>73</b>	<b>33</b>

*Source: Employer interviews conducted by Washington State University*

## Contracted Employment

Some employers rely on contracted employment to support work functions or tasks characteristic of skilled mid-level occupations. Because contracted employment is provided by external companies or individual contractors, they are not reported above. None of the five employers rely systematically on

contract hiring to perform regular mid-level technical work. More often, they occasionally contract for specialized, short-term consulting or engineering services, equipment-specific repairs, general contracting or specialized services such as pumping, which is infrequent and cheaper to outsource periodically than purchasing and maintaining the necessary equipment internally. Some companies do hire additional temporary employees during peak seasons, such as during harvest. While other agricultural employers may rely on temporary agencies to hire additional workers during peak periods, these five employers do not.

### **Agriculture: Knowledge, Skills, Abilities and Pathways**

The following sections highlight data collected directly from participating employers. This data focuses on the primary knowledge, skills and abilities employers said they needed for each of the high-priority occupations they identified. Interview topics included technical skills, other important knowledge, skills and abilities, formal preparation, typical entry pathways, and next-level employment (advancement).

**Technical Skills:** Employers were asked to describe the leading core technical skills and specific technical skills they saw as especially important to have in these high priority jobs. The technically related knowledge, skills and abilities reported below are not meant to represent comprehensive job descriptions or requirements, but rather reflect the general topics and skill sets that these employers viewed as essential competencies for these positions.<sup>25</sup>

Employers place considerable emphasis on mechanical, electrical and electronic knowledge and skills, especially as they relate to production system operations and performance (refer to **Table 7: Core and Specific Technical Skills by Job Title in Agriculture**). Employers emphasized that these skills should also include basic knowledge of computer hardware and software, with specific knowledge of computer-controlled systems that relate to production processes and operations, quality control, preventive maintenance, troubleshooting and repair. The ability to read schematics and operating manuals was often mentioned as a necessary skill, along with basic math and chemistry knowledge. These findings are further corroborated by the Burning Glass data set, which identified similar skills sets listed in job-postings for high priority occupations identified by employer interviews (refer to **Appendix 3** for tables pertaining to skills, industry and county specific job-postings captured by Burning Glass).

**Table 7: Core and Specific Technical Skills by Job Title in Agriculture**

<b>Job Title</b>	<b>Core Technical Skills</b>	<b>Specific Technical Skills</b>
Maintenance Engineer	<ul style="list-style-type: none"> <li>• Knowledge of electrical schematics (24v, 110v, 220v, and 480v systems)</li> <li>• Theoretical mastery of process flow</li> <li>• Understanding of PLCs</li> <li>• Knowledge of boiler operation and repair</li> <li>• Ensure ongoing operation of process machinery and mechanical equipment</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledgeable in the areas of mechanical machinery, steam, boiler, pneumatic and hydraulic operations</li> <li>• Proficiency in effective and efficient troubleshooting methods</li> <li>• Welding skills</li> </ul>

<sup>25</sup> These data were reviewed, compared and, in some cases, supplemented through analyses of job descriptions provided by the individual companies. Web-based occupational resources such as the Bureau of Labor Statistics and electronic job postings were also used to review skills and competencies.

	<ul style="list-style-type: none"> <li>• Ability to perform preventive maintenance on engines, motors, pneumatic tools, conveyor systems and production machines</li> <li>• Interpret diagrams, sketches, operations manuals, manufacturer's instructions and engineering specifications</li> </ul>	
Service Tech	<ul style="list-style-type: none"> <li>• Computational math (algebra) for calculating percentages of fertilizers, chemicals and other solutions</li> <li>• Unit conversions (e.g., ounces to pounds)</li> <li>• Computer skills for filling orders and communicating with co-workers and clients</li> <li>• Mechanical understanding of pump systems, liquid flow and liquid volumes</li> <li>• Mechanical knowledge of electrical pumps</li> <li>• Knowledge of vehicle maintenance</li> </ul>	<ul style="list-style-type: none"> <li>• Calibration, maintenance and operation of application equipment</li> <li>• Ability to calculate rates and nutrient values for fertilizer mixes and loads</li> <li>• Ability to read and understand crop protection product labels and mixing instructions</li> <li>• Knowledge of liquid flow and gravity in a plumbing context</li> </ul>
Production Supervisor	<ul style="list-style-type: none"> <li>• Computer skills (Word, Excel, Outlook, and software used in production tracking systems)</li> <li>• Knowledge of Good Manufacturing Processes</li> <li>• Ability to develop self-directed teams to troubleshoot and resolve manufacturing issues</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge of dairy processing</li> <li>• Ability to develop an expert knowledge of the production process and all associated equipment</li> <li>• Ability to analytically and systematically troubleshoot manufacturing issues</li> <li>• Knowledge of evaporators, dryers and separators as they relate to dairy products and processing</li> </ul>
Service Manager	<ul style="list-style-type: none"> <li>• Computational math (algebra) for calculating percentages of fertilizers, chemicals and other solutions</li> <li>• Computer skills for filling orders and communicating with co-workers and clients</li> <li>• Knowledge of liquid flow and gravity in a plumbing context</li> <li>• Mechanical knowledge of electrical pumps</li> <li>• Knowledge of vehicle maintenance</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge of and ability to communicate economic information to the grower</li> <li>• Knowledge of federal and state guidelines regarding the regulation of pesticides, herbicides and fertilizers</li> </ul>
Process Mechanic	<ul style="list-style-type: none"> <li>• Knowledge of mechanical components (sprockets, pulleys, belts and motors) as part of a system</li> <li>• Welding ability</li> </ul>	<ul style="list-style-type: none"> <li>• Maintains company standards for safety, quality, food safety, sanitation and GMPs</li> <li>• Ensures proper food safety sanitation and cleaning procedures of all process and packaging equipment and systems</li> </ul>
Boiler Maintenance Mechanic	<ul style="list-style-type: none"> <li>• Refrigeration background</li> <li>• Knowledge of how to work with hydrogen, bio-gas and natural gas</li> <li>• Diagnostic skills and tools</li> </ul>	<ul style="list-style-type: none"> <li>• Support the efficient operation of all equipment in the boiler and refrigeration areas</li> <li>• Use preventive maintenance, troubleshooting, overhauling and repair equipment to achieve operational goals</li> </ul>
Electrician	<ul style="list-style-type: none"> <li>• Knowledge of controls systems</li> <li>• Computer skills for working with electrical systems</li> <li>• Understanding of PLC</li> </ul>	<ul style="list-style-type: none"> <li>• Comprehensive knowledge of the National Electrical Code (NEC) and the standards for Electrical Safety in the Workplace (NPA70E)</li> </ul>
Seed Mill/Warehouse Tech	<ul style="list-style-type: none"> <li>• Strong understanding of proportions, ratios, volumes and measure conversions</li> </ul>	<ul style="list-style-type: none"> <li>• Computer skills for programing automated machines for blending solutions of</li> </ul>

	<ul style="list-style-type: none"> <li>required for blending solutions</li> <li>• Strong mechanical aptitude</li> </ul>	pesticides, herbicides and fertilizers
Electro Mechanic	<ul style="list-style-type: none"> <li>• Ability to wire a motor, rebuild pumps and use a volt meter</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge of mechanical processes for automated machinery in a food-processing plant setting</li> </ul>
Production Tech	<ul style="list-style-type: none"> <li>• Knowledge of hydraulics</li> <li>• Forklift skills</li> <li>• Basic lab skills</li> <li>• Data entry skills</li> <li>• Maintenance skills</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding of process technologies used to create, process and package fruit beverage products</li> </ul>
Electro Mechanic A	<ul style="list-style-type: none"> <li>• Ability to wire a motor, rebuild pumps and use a volt meter</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge of mechanical processes for automated machinery in a food-processing plant setting</li> </ul>
Cider Maker	<ul style="list-style-type: none"> <li>• Advanced lab skills</li> <li>• Understanding of pumps and chemicals</li> <li>• Capacity to comprehend technical lab data</li> <li>• Knowledge of production equipment and operations</li> <li>• Understanding of quality control processes and implementation</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding of: <ul style="list-style-type: none"> <li>○ Fermentology</li> <li>○ Recipe development and management</li> <li>○ Governmental/industry regulations and requirements</li> </ul> </li> </ul>
Lab Technologist	<ul style="list-style-type: none"> <li>• Lab skills and procedures</li> <li>• Proficiency in scientific methods</li> <li>• Background in cell biology or micro biology</li> </ul>	<ul style="list-style-type: none"> <li>• Maintain records</li> <li>• Ability to conduct process and product quality analysis and testing</li> <li>• Ensure compliance with quality standards and requirements</li> </ul>
Maintenance Electrician	<ul style="list-style-type: none"> <li>• Understanding of PLC</li> <li>• Ladder Logic (computer language used for PLCs)</li> <li>• Knowledge of Variable Frequency Drives (VFDs)</li> <li>• Ability to bench test motors</li> <li>• Mechanical skills</li> </ul>	<ul style="list-style-type: none"> <li>• EL1 Certification (Washington state journeyman license)</li> <li>• Mechanical aptitude in a food processing context</li> </ul>
Mechanic	<ul style="list-style-type: none"> <li>• Knowledge of electrical power (3 phase and single phase) and electric motors</li> <li>• Ability to troubleshoot motors, conveyer belts and hydraulics</li> <li>• Ability to read technical manuals to understand equipment and controls</li> <li>• Ability to disassemble machinery and equipment when there is a problem</li> <li>• Detect minor problems by performing basic diagnostic tests</li> <li>• Test malfunctioning machinery to determine if major repairs are needed</li> <li>• Move machinery and equipment</li> </ul>	<ul style="list-style-type: none"> <li>• Ability to weld on pressure equipment</li> <li>• Adjust and calibrate equipment and machinery to optimal specifications</li> <li>• Perform tests and run initial batches to ensure the machine runs smoothly</li> <li>• Repair or replace broken or malfunctioning components</li> <li>• Clean and lubricate equipment or machinery</li> <li>• Use computer skills to find inventory parts</li> </ul>

**Source: Employer interviews conducted by Washington State University**

**Agriculture: Other Knowledge, Skills and Abilities (KSAs):** Many employers re-stated the importance of technical competencies in the context of generic skills and knowledge that may also be applicable to many types of occupations and functions, such as troubleshooting, basic computational ability and safety. More often, employers emphasized foundational skills such as teamwork and being a “team player,” problem solving, being self-directed, and having good communication and social skills. Sensitivity to diverse backgrounds was a

common desirable trait, as was the ability to anticipate problems and ask appropriate questions. Personal qualities such as having a good work ethic, a positive attitude, and being honest and ethical were also emphasized by many employers (refer to **Table 8: Other KSAs by Job Title in Agriculture**).

**Table 8: Other Knowledge, Skills and Abilities by Job Title in Agriculture (KSAs)**

Job Title	Other KSAs
Maintenance Engineer	<ul style="list-style-type: none"> <li>• Proactively anticipate problems</li> <li>• Troubleshooting</li> <li>• Mechanical aptitude</li> <li>• Written and verbal communication skills</li> <li>• Ability to ask pointed questions to help solve problems</li> <li>• Ability to work in teams comprising diverse individuals</li> </ul>
Service Tech	<ul style="list-style-type: none"> <li>• Troubleshooting</li> <li>• Proactively anticipate problems</li> <li>• Critical thinking</li> <li>• Verbal communication skills</li> <li>• Sensitive to the diverse backgrounds of business partners</li> </ul>
Production Supervisor	<ul style="list-style-type: none"> <li>• Understanding of systems</li> <li>• Organization, planning and time management</li> <li>• Verbal communication skills</li> <li>• Motivated self-starter</li> <li>• Ability to ask pointed questions to help solve problems</li> <li>• Proactively anticipate problems</li> <li>• Ability to achieve results through others</li> <li>• Ability to work in teams comprising diverse individuals</li> </ul>
Service Manager	<ul style="list-style-type: none"> <li>• Organization skills</li> <li>• Verbal and written communication skills</li> <li>• Ability to proactively anticipate problems</li> <li>• Strong people management skills</li> <li>• Sensitive to the diverse backgrounds of business partners</li> <li>• A “systems” understanding of the production process</li> </ul>
Process Mechanics	<ul style="list-style-type: none"> <li>• Trouble shooting</li> <li>• Mechanical aptitude</li> <li>• Understanding of mechanical components as part of a system</li> <li>• Not afraid to ask questions</li> <li>• Safety conscious</li> <li>• Methodical</li> </ul>
Boiler Maintenance Mechanic	<ul style="list-style-type: none"> <li>• Reliable</li> <li>• Can follow procedural protocols</li> <li>• Able to stay calm and focused in tense situations</li> <li>• Good work ethic and attitude</li> <li>• “Confidence without arrogance”</li> </ul>
Electrician	<ul style="list-style-type: none"> <li>• Troubleshooting</li> <li>• Mechanical aptitude</li> <li>• Capacity to take pride in work and to take ownership</li> <li>• Not afraid to ask questions</li> </ul>
Seed Mill/ Warehouse Tech	<ul style="list-style-type: none"> <li>• Verbal communication skills for interfacing with customers and growers</li> <li>• Attention to detail</li> </ul>
Electro Mechanic	<ul style="list-style-type: none"> <li>• Conduct risk assessments necessary for prescribing appropriate PPE (Personal Protective Equipment)</li> </ul>

	<ul style="list-style-type: none"> <li>• Ability to use basic hand tools and a lathe</li> <li>• Knowledge about bearings</li> <li>• Troubleshooting</li> <li>• Problem solving</li> <li>• Safety conscious</li> <li>• Honest and open</li> <li>• Prefers to work in teams</li> </ul>
Production Tech	<ul style="list-style-type: none"> <li>• Basic math skills</li> <li>• Reading and writing ability</li> <li>• Can work in teams</li> <li>• Good work ethic and attitude</li> <li>• Prefer over 18 years old for working with machinery used in alcohol production</li> </ul>
Electro Mechanic A	<ul style="list-style-type: none"> <li>• Conduct risk assessments necessary for prescribing appropriate PPE</li> <li>• Ability to use basic hand tools and a lathe</li> <li>• Knowledge about bearings</li> <li>• Troubleshooting</li> <li>• Problem solving</li> <li>• Safety conscious</li> <li>• Honest and open</li> <li>• Prefers to work in teams</li> </ul>
Cider Maker	<ul style="list-style-type: none"> <li>• Aptitude for tasting and blending</li> <li>• Basic chemistry</li> <li>• Algebra skills</li> </ul>
Lab Technologist	<ul style="list-style-type: none"> <li>• Basic chemistry</li> <li>• Algebra skills</li> <li>• Verbal communication skills</li> <li>• Can work in teams</li> <li>• Good work ethic and attitude</li> <li>• Prefer over 18 years old for working with alcohol related machinery</li> </ul>
Maintenance Electrician	<ul style="list-style-type: none"> <li>• Can work in teams</li> <li>• Good work ethic and attitude</li> <li>• Identify problems and provide solutions</li> <li>• Troubleshooting</li> <li>• Safety conscious</li> <li>• Address lighting issues in shop</li> <li>• Run wire and conduit</li> <li>• Mechanical aptitude</li> </ul>
Mechanic	<ul style="list-style-type: none"> <li>• Can work in teams</li> <li>• Communication skills</li> <li>• Good work ethic and attitude</li> <li>• Organization skills</li> </ul>

**Source: Employer interviews conducted by Washington State University**

**Agriculture: Formal Preparation:** All employers require a high school or equivalent degree for employment, and nearly all reported that they have additional occupation-specific requirements for most positions. Related work experience, education and training, or some combination of experience and training is required for employment in most positions. In some cases, specific licenses or certifications are required, and may include state-level licensure, such as for electricians. Specialized credentials or certification in occupation-specific work or specialized equipment (lift trucks) or personal protective equipment (respirators), are sometimes required as a condition of employment or continued employment (refer to **Table 9: Required Formal Preparation in Agriculture**).

**Table 9: Required Formal Preparation in Agriculture**

Job Title	Required Formal Preparation
Maintenance Engineer	<ul style="list-style-type: none"> <li>High school degree is the minimum, though some trade school experience is a plus</li> <li>Boiler Operators License (minimum of second class)</li> <li>Minimum of 3 years' experience in mechanical/electrical maintenance, or instrumentation certification</li> </ul>
Service Tech	<ul style="list-style-type: none"> <li>High school degree</li> <li>College studies in agriculture-related studies a plus but not required</li> <li>CDL driver's license with Tank and Hazmat endorsements (Class B or above; Class A preferred)</li> </ul>
Production Supervisor	<ul style="list-style-type: none"> <li>Dairy/food processing experience is required</li> <li>High school degree is the minimum, though it really helps if individuals have completed some post-secondary course work in leadership, conflict resolution, or public speaking</li> <li>Dairy experience would be acceptable in place of formal education</li> </ul>
Service Manager	<ul style="list-style-type: none"> <li>High school degree</li> <li>2- or 4-year college degree in accounting-related study</li> <li>CDL driver's license with Tank and Hazmat endorsements (Class B or above; Class A preferred)</li> <li>Dealer Manager License, or state equivalent</li> <li>Commercial Pesticide Operator License, or state equivalent, and all necessary endorsements</li> <li>College studies in agriculture-related discipline a plus but not required</li> <li>3-5 years of agricultural sales experience with equipment or products and services</li> </ul>
Process Mechanics	<ul style="list-style-type: none"> <li>High school or equivalent</li> <li>Experience (not necessarily employed) working on equipment from a mechanical perspective (i.e., auto repairs)</li> </ul>
Boiler Maintenance Mechanic	<ul style="list-style-type: none"> <li>Must obtain a CIRO (Certified Industrial Refrigeration Operator) or CARO (Certified Assistant Refrigeration Operator) Certificate within 6 months</li> <li>Must obtain and maintain a respirator equipment certification</li> <li>Must maintain Power Industrial Truck (Lift Truck) certification</li> </ul>
Electrician	<ul style="list-style-type: none"> <li>High school or equivalent</li> <li>A minimum of 2 years industrial factory electrical maintenance and troubleshooting experience, or equivalent education as approved by the Electrical Maintenance Supervisor and Department Manger</li> </ul>
Seed Mill/ Warehouse Tech	<ul style="list-style-type: none"> <li>High school degree</li> <li>Two-year post high school degree helpful but not required</li> <li>CDL driver's license with Tank and Hazmat endorsements (Class B or above; Class A preferred)</li> </ul>
Electro Mechanic	<ul style="list-style-type: none"> <li>High school or equivalent education</li> <li>2-4 years' experience in related field, which includes 2 years' experience at the company working the Electro Mechanic A position</li> </ul>
Production Tech	<ul style="list-style-type: none"> <li>High school degree</li> </ul>
Electro Mechanic A	<ul style="list-style-type: none"> <li>High school or equivalent education</li> <li>1-3 years' experience in a related field</li> </ul>
Cider Maker	<ul style="list-style-type: none"> <li>Requires training or work experience beyond a high school degree in the field of wine/cider blending and fermentation</li> <li>Training in cell biology or micro-biology</li> <li>Education in horticulture</li> </ul>
Lab Technologist	<ul style="list-style-type: none"> <li>Typically requires some training or work experience beyond high school to acquire desired lab experience</li> </ul>

	<ul style="list-style-type: none"> <li>• Training in cell biology or micro-biology</li> </ul>
Maintenance Electrician	<ul style="list-style-type: none"> <li>• High school or equivalent education</li> <li>• Washington State EL01 Journeyman License</li> </ul>
Mechanic	<ul style="list-style-type: none"> <li>• Requires some education or experience beyond a high school degree</li> </ul>

**Source: Employer interviews conducted by Washington State University**

**Agriculture Typical Entry Pathways:** As shown below, there are similarities among the occupations regarding entry pathways; in general, however, the typical pathways into these positions follow two primary approaches (refer to **Table 10: Typical Occupational Pathways in Agriculture**):

1. Experience in the occupation, or in related employment, that provides sufficient background and knowledge to qualify for employment in the position. Some employers said that having a background in farm work was a typical route to the job.
2. Education and training that is directly or closely related to the skill requirements of the occupation, including apprenticeships, college or technical program degrees, or related industry-recognized licenses or certifications.

**Table 10: Typical Occupational Pathways in Agriculture**

Job Title	Typical Pathways
Maintenance Engineer	Most qualified candidates come from outside the company having a minimum of 2 years of mechanical experience, but this experience can be a combination of trade school and work experience. Experienced machine operators can occasionally be transferred into this job.
Service Tech	Individuals typically come into this entry-level position from a background of farm work and basic mechanical experience repairing farm equipment. From here, qualified candidates receive on-the-job training through a mentoring program that pairs them with an experienced Service Technician.
Production Supervisor	Typically, qualified candidates have a minimum of 2 years of management experience in a food manufacturing setting. The company also has a summer internship management program designed to give interested and qualified individuals experience in a plant. This program leads into a 9-12 month trainee program that is designed to provide the necessary food production experience.
Service Manager	Individuals typically come into this position from a background in farm work and basic mechanical and technical/technician experience in a farming environment. Qualified candidates receive on-the-job training through a mentoring program that pairs them with an experienced Service Manager.
Process Mechanic	Trade school is the typical path into this job. The company also offers an apprenticeship program.
Boiler Maintenance Mechanic	Trade school is the typical path into this job.
Electrician	Trade school is the typical path into this job, though 4 years of work experience would also be appropriate.
Seed Mill/ Warehouse Tech	Individuals typically come into this entry-level position from a background in farm work and basic mechanical experience repairing farm equipment. From here, qualified candidates receive on-the-job training through a mentoring program that pairs them with an experienced Seed Mill/Warehouse Worker.
Electro Mechanic	Individuals are promoted to this position following 2 years working for the company as an Electro Mechanic A, which reflects a union-contracted collective bargaining agreement with the company.

Production Tech	Typically, qualified candidates have acquired some training or experience post high school.
Electro Mechanic A	Typically, qualified candidates have acquired a minimum of 2 years of work experience in related work, but they could come in with a 2-year trade school degree.
Cider Maker	Qualified candidates have a 2-year degree in fermentation, are promoted from assistant to the Cider Maker or have prior wine or cider blending experience.
Lab Technologist	Individuals would typically need some education beyond high school to get the required lab experience, though if they took chemistry and acquired lab experience in high school, they would also be qualified.
Maintenance Electrician	Qualified candidates have acquired their EL1 Certification (Washington state journeyman license), which is a 5-year on the job certification process.
Mechanic	Individuals come into this position from a mechanical position at a local company, but they could come in with a 2-year mechanic/trade school degree.

*Source: Employer interviews conducted by Washington State University*

**Agriculture Next-Level Employment:** All employers reported that there are pathways for advancement into other positions. In most cases, the opportunities for career advancement included vertical promotion into next-level technical positions, or into supervisory or management occupations. These employers did not express a requirement for a four-year degree for vertical mobility, but did report that additional education and training in related areas was desirable. Lateral advancement into other departments such as administration, finance, shipping or other functional areas are also possible. In some cases, especially in smaller companies, the number of senior-level positions is limited, and advancement opportunities are more available outside of technical positions or by pursuing employment opportunities at other companies or industries (refer to **Table 11: Next-Level Employment Opportunities in Agricultural Careers**).

**Table 11: Next-Level Employment Opportunities in Agricultural Careers**

Job Title	Next-Level Employment Opportunities
Maintenance Engineer	Promotion to Maintenance Supervisor, which can be followed by a move to Maintenance Manager. From here, it is possible to move into Plant Manager or Corporate Engineering. Those with interest in computers can move into a corporate position as a Programmer for project controls
Service Tech	Service Technicians (ST) move to ST2 and then ST3. ST3s can continue on to ST4 or move into Account Manager (fast track) or Service Manager. ST4s can also move into Account Manager, Service Manager, but also Service Center Manager or other advancement opportunities
Production Supervisor	Promotion to Product Manager, Purchasing (supply chain), or Quality Assurance
Service Manager	Lateral movement to Service Center Manager, Account Manager or other advancement opportunities
Process Mechanics	Lateral transfer into predictive maintenance, potential for supervisory positions
Boiler Maintenance Mechanic	Promotion to Process Safety Management or Boiler Systems Supervisor
Electrician	Advancement comes in the form of position upgrades and pay increases with time at the company and successful completion of required exams
Seed Mill/ Warehouse Worker	Potential advancement, with training, into service, production, maintenance or supervisory positions
Electro Mechanic	Promotion into management as a Maintenance Supervisor, Maintenance Planner, or Technical Service Manager

Production Tech	Potential advancement, with training, into maintenance, supervisory or administrative positions
Electro Mechanic A	Promotion to Electro Mechanic. From here, individuals can be promoted into management as a Maintenance Supervisor, Maintenance Planner or Technical Service Manager
Cider Maker	Potential movement into senior Cider Maker position if available, and advancement to similar positions in other companies or related industries
Lab Technologist	Promotion to other technical jobs with additional training/education or to Cider Maker
Maintenance Electrician	Promotion into management as a Maintenance Supervisor, Maintenance Planner or Technical Service Manager
Mechanic	Senior-level mechanic or supervisory position

**Source: Employer interviews conducted by Washington State University**

## Natural Resources Sector

### Industry Description

Washington’s abundant natural resources provide a diverse foundation for local economies and employment across the state. Forestland covers almost half the state, and nearly 21 million acres are used for commercial timber. Timber and forest products are by far the most prevalent and diverse part of the state’s natural resource economic base, supported by ample rainfall and other conditions that provide a healthy ecosystem for timberlands. Washington is also a recognized leader in farming and fishing and, with its ample water resources, is also the nation’s leading generator of hydroelectric power.

The state, federal, and private entities manage vast timberlands that support a broad range of companies engaged in operating timber tracts, nurseries, seeding reforestation, and harvesting timber and other forest products. The sector includes related services such as cutting, logging, transporting, estimating and other forest management services. Forest products are primary inputs for lumber, fencing, pulp and paper, and finished products such as doors and window frames. Wood Product Manufacturing is the third-largest manufacturing sub-sector in the state. In all, more than 1,700 companies are related to forest products, generating a gross income of approximately \$28 billion per year and supporting employment of an estimated 106,000 workers.<sup>26</sup>

Although Wood Product Manufacturing is an important industry, and is linked the Natural Resource sector, it is also categorically different and therefore not included in this sector. The inclusion of wood product manufacturing into the natural resource sector would also significantly alter any descriptive statistics about the natural resource sector given the sheer size of this manufacturing sub-sector. However, this report also recognizes the critical linkages between natural resources and wood product manufacturing, and will explore the natural resources sector with the inclusion of wood product manufacturing separately in terms of analyzing industry size and employment counts using government data.

Moreover, the critical linkages between the forestry and logging natural resources sub-sector and the wood product manufacturing sub-sector have resulted in some businesses organizing themselves

<sup>26</sup> Washington State Department of Commerce (2018). <https://www.commerce.wa.gov/growing-the-economy/key-sectors/forest-products/>. Data on companies, revenue and employment estimates are for 2014.

vertically across both sectors. For this reason, employer interviews assessing in- demand skills and occupations will be examined holistically.

It is important to note here some industries do overlap across sectors; such is the case for Forestry and Logging into the Agricultural sector. Forestry and Logging, and Utilities account for two-thirds of the employment in this sector. In 2016 there were on average nearly 12,600 employed in the sector earning \$78,271 annually. The utilities industry, in addition to being the largest employer also had the highest annual wage at \$88,312. Overall the sector wage rate of \$78,271 is somewhat above the \$58,928 rate for all other industries (refer to **Table 12: Natural Resources Sub-industry Breakout**).

**Table 12: Natural Resources Sub-industry Breakout**

*Washington State, 2016 Annual Averages*

Industry description	Avg. firms	Total 2016 wages paid	Average annual employment	Average annual wage
Forestry and logging	454	\$274,299,337	3,876	\$70,769
Fishing, hunting and trapping	230	\$124,406,921	1,477	\$84,229
Mining	160	\$160,051,303	2,375	\$67,390
Utilities	223	\$402,966,507	4,563	\$88,312
Geophysical surveying and mapping services	22	\$21,755,405	274	\$79,399
<b>Total</b>	<b>1,089</b>	<b>\$983,479,473</b>	<b>12,565</b>	<b>\$78,271.35</b>

*Source: Washington State Employment Security Department, QCEW Annual Averages*

The Natural Resources sector, which enjoys higher wages, has also experienced a decline in direct employment and the numbers of firms operating in the sector. It may be possible that some of this decline can be attributed to a transition to contract employment, which is not captured by ESD (refer to **Table 13: Natural Resources Sector Snapshot**).

**Table 13: Natural Resources Sector Snapshot**

*Washington State, 2014-2016 Annual Averages*

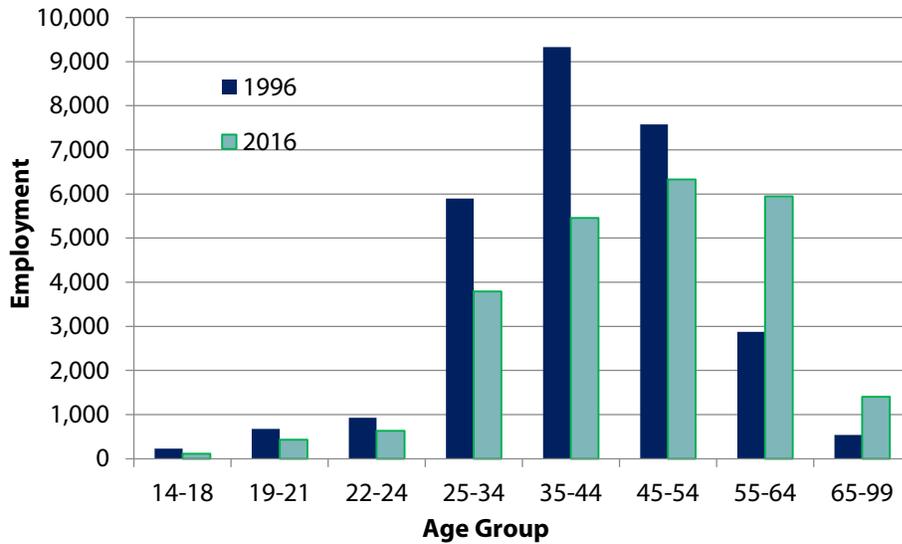
Year	Avg. firms	Total wages paid	Average annual employment	Average annual wage
2014	1,204	\$936,636,982	12,730	\$73,577
2015	1,148	\$986,048,112	13,077	\$75,403
2016	1,089	\$983,479,473	12,565	\$78,271

*Source: Washington State Employment Security Department, QCEW Annual Averages*

Like Agriculture, the natural resources sector has an older and rapidly aging workforce. In 1996, the largest age cohort was 35-44 year-olds, followed by the 45-to-54 year-olds. By 2016, 45-54 year-olds were the largest group followed by 55-64 year-olds (refer to **Chart 2: Changing Age Patterns in Natural Resources Employment**).

## Chart 2: Changing Age Patterns in Natural Resources Employment

Washington State, 2006 & 2016



Source: U.S. Census Bureau, LEHD

The employment in utilities is a significant portion of jobs in the Natural Resources sector, with occupations such as power line installers and water treatment plant operators making up large portions of the total (refer to **Table 14: Top Mid-level Occupations in Natural Resources by Area**).

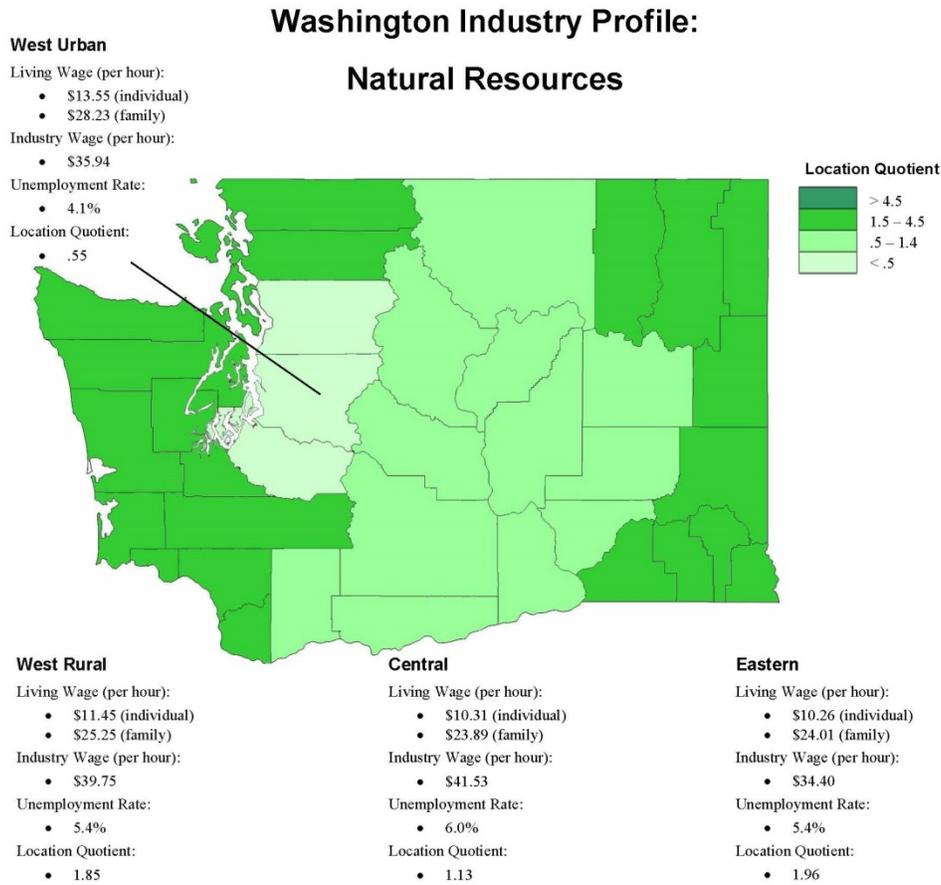
**Table 14: Top Mid-level Occupations in Natural Resources by Area**

Occupational Title	Regions				Totals
	West Rural	West Urban	Central	East	
Electrical Power-Line Installers and Repairers	59	149	59	145	412
Water and Wastewater Treatment Plant and System Operators	144	126	83	19	372
Mobile Heavy Equipment Mechanics, Except Engines	219	46	16	24	305
Power Plant Operators	55	89	34	78	256
Maintenance and Repair Workers, General	38	17	41	13	109
Bus and Truck Mechanics and Diesel Engine Specialists	52	23	8	1	84
Purchasing Agents, Except Wholesale, Retail, and Farm Products	8	34	1	7	50
Power Distributors and Dispatchers	6	23	3	1	33
Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	6	4	6	15	31
Plumbers, Pipefitters, and Steamfitters	5	19	3	0	27
Electricians	11	8	1	2	22
Gas Plant Operators	6	14	0	2	22
Stationary Engineers and Boiler Operators	3	13	0	0	16
Industrial Machinery Mechanics	1	0	13	0	14
Wind Turbine Service Technicians	1	0	11	0	12
Electric Motor, Power Tool, and Related Repairers	2	5	0	0	7
Carpenters	3	0	2	1	6
Millwrights	6	0	0	0	6
Electrical and Electronics Installers and Repairers, Transportation Equipment	0	4	0	0	4
Electrical and Electronics Repairers, Commercial and Industrial Equipment	2	0	0	1	3
Claims Adjusters, Examiners, and Investigators	0	2	0	0	2
Wholesale and Retail Buyers, Except Farm Products	1	0	0	0	1
Telecommunications Line Installers and Repairers	1	0	0	0	1

**Source:** *Washington State Employment Security Department*

Electrical Power Line Installers are the most common skilled mid-level occupation in the Natural Resources sector. State-wide employment in 2016 for this occupation was 412, with the highest number coming from the West Urban region, 149, followed closely by the East Region, 145. Water Treatment Plant Operators had the second highest employment level in Natural Resources, then Heavy Equipment Mechanics. There are some occupations that stand out in **Table 14**, such as Wind Turbine Service Technicians that are almost exclusive to the Central region. Again, occupational composition within the sector varies by region (refer to **Exhibit 3: Washington Industry Profile – Natural Resources** for an overall snapshot of location quotients for occupational intensity by regions as it pertains to the Natural Resources sector).

### Exhibit 3: Washington Industry Profile – Natural Resources



**Source: Washington State Employment Security Department**

### Natural Resources Sub-industry Breakout with Wood and Fiber Products Manufacturing

Wood Products Manufacturing is defined as the downstream processing of wood fiber. It would include the 3-digit NAICS sub-industries of sawmills, engineered wood, pulp & paper mills, and converted paper manufacturing. Again, Wood Products Manufacturing was initially left out because the large size of the industry substantially changes the overall characteristics the Natural Resource sector, and tends to crowd out insights from other aspects of the sector (refer to **Table 15:** for a sub-industry breakout of Natural Resources with Wood and Fiber Products Manufacturing).

**Table 15: Natural Resources with Wood and Fiber Products Manufacturing Sub-industry Breakout**

Washington State, 2016 Annual Averages

Industry description	Avg. firms	Total 2016 wages paid	Average annual employment	Average annual wage
Forestry and logging	454	\$274,299,337	3,876	\$70,769
Wood product manufacturing	366	\$648,934,870	12,903	\$50,293
Paper manufacturing	93	\$583,902,596	7,740	\$75,440
Fishing, hunting and trapping	230	\$124,406,921	1,477	\$84,229
Mining	160	\$160,051,303	2,375	\$67,390
Utilities	223	\$402,966,507	4,563	\$88,312
Geophysical surveying and mapping services	22	\$21,755,405	274	\$79,399
<b>Total</b>	<b>1,548</b>	<b>\$2,216,316,939</b>	<b>33,208</b>	<b>\$66,740.45</b>

*Source: Washington State Employment Security Department, QCEW Annual Averages*

Adding in Wood Products would have a significant impact on the overall numbers for Natural Resources. The number of firms would be 30 percent higher (in 2016), the total wages paid out 56 percent higher, and average employment 62 percent higher. However, given the lower average annual wages in wood products manufacturing, it would bring down average annual wages by 17 percent (refer to **Table 16:** for Natural Resources Trends with Wood and Fiber Products Manufacturing included).

**Table 16: Natural Resources Trends with Wood and Fiber Products Manufacturing**

Washington State, 2014-2016 Annual Averages

Year	Avg. firms	Total wages paid	Average annual employment	Average annual wage
2014	1,666	\$2,185,146,379	34,055	\$64,165
2015	1,603	\$2,239,642,020	34,167	\$65,550
2016	1,548	\$2,216,316,939	33,208	\$66,740

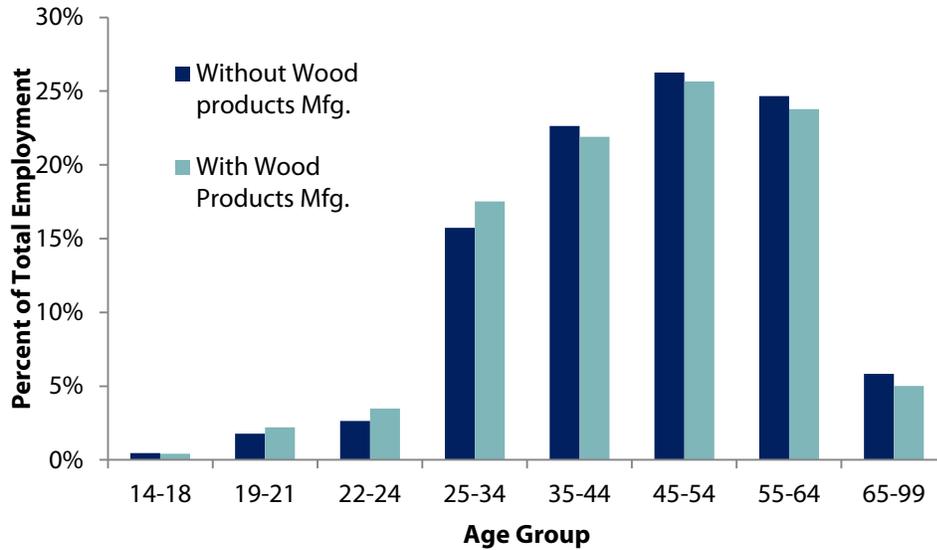
*Source: Washington State Employment Security Department, QCEW Annual Averages*

The effect of the Wood Products Manufacturing industry on the overall Natural Resources sector played out in similar ways over the entire 2014-2016 period.

By adding in Wood Products Manufacturing, the workforce is somewhat younger, but still reflects an aging workforce. The percent of the wood products workforce in age groups 34 and younger was higher than that of the Natural Resources sector on its own (refer to **Chart 3:** for Age of Natural Resources and Wood and Fiber Products Manufacturing Workforce).

### Chart 3: Age of Natural Resources and Wood Products Manufacturing Workforce

Washington State, 2016 Annual Averages



Source: U.S. Census Bureau, LEHD

Of the 20,000 or so workers in the Wood Products Manufacturing industry, the largest share, 28%, work in sawmills. This pattern is borne out when looking at top occupations (refer to **Table 17:** for top occupations in wood products manufacturing). Of the top seven occupations listed, six are found commonly working in sawmills, with paper goods setters being the exception. Moreover, 345 of the 610 millwrights found in Wood Products Manufacturing were in sawmills, which is the sub-sector most closely aligned with natural resources.

**Table 17: Top Occupations in Wood Products Manufacturing**Washington State, 2016 2<sup>nd</sup> Quarter

Occupation	Sawmills and wood preservation	Plywood and engineered wood product mfg.	Other wood product mfg.	Pulp, paper, and paperboard mills	Converted paper product mfg.	Total for All Wood Products mfg.
Woodworking Machine Setters and Operators	420	500	723	33		1,676
Sawing Machine Setters and Operators	893	270	418	48		1,629
Paper Goods Machine Setters and Operators	1			900	570	1,471
Machine Feeders and Offbearers	374	100	650	31	98	1,253
Industrial Truck and Tractor Operators	379	155	222	178	106	1,040
Supervisors of Production and Operating Workers	243	160	228	157	165	953
Laborers and Freight, Stock, and Material Movers, Hand	273	52	266	175	108	874
Team Assemblers		467	357	3	17	844
Millwrights	345	31	18	216		610
Helpers--Production Workers	63	218	95	38	193	607
Industrial Machinery Mechanics	131	4	13	313	62	523
Shipping, Receiving, and Traffic Clerks	50	12	78	218	113	471
Sales Reps, Wholesale and Manufacturing	56	88	135	37	153	469
Maintenance and Repair Workers, General	136	28	66	130	81	441
Logging Equipment Operators	345			59		404
Heavy and Tractor-Trailer Truck Drivers	115	81	24	121	46	387
General and Operations Managers	59	50	107	38	113	367
Cutting and Slicing Machine Setters, Operators, and Tenders				137	224	361
Inspectors, Testers, Sorters, Samplers, and Weighers	149	33	49	40	25	296
Log Graders and Scalers	234		7	52		293
Supervisors of Mechanics, Installers, and Repairers	60	11	11	130	5	217
Customer Service Representatives	9		31	13	156	209

**Source: U.S. Census Bureau, LEHD****Note: the wood products manufacturing occupations table is not screened for mid-level occupations.**

## Employer Interviews: Natural Resources & Wood Product Manufacturing Sector Trends

Companies in the Natural Resource sector have experienced major transformations in technology, as well as in business practices that stem from broader shifts in the market. The computerization and automation of manufacturing systems have revolutionized the processing and production of lumber and wood products. These innovations and advanced integrated technologies, shift the work conducted by skilled mid-level workers such as millwrights beyond the traditional work of installing, maintaining and repairing mostly mechanical systems and components; the work now requires extensive knowledge of how mechanical, electrical and electronic systems interact. One millwright manager observed: “As an industry, I only see us getting more and more reliant on computers and automation processes. If you had told me ten years ago that a log sorter (worker who measures, grades and sorts logs) – the same sorter that’s been here for 20 years – would now be monitoring operations through an iPad, I would have never guessed it.”

“As an industry, I only see us getting more and more reliant on computers and automation processes.”

In timber management operations, another technological trend is the use of aerial drones for mapping and surveying large forested areas. One human resources manager noted: “If we can view the area faster to make prescriptions to get the (forest management) work done, it would be better.” The same manager described the use of drones to plant new trees: “Some companies use drones to plant seedlings (to drop small seed balls) – 10,000 trees in a day.” As the uses for drones become more prevalent, knowledge of related factors such as spot weather forecasting, wind speed and direction, will also become vital.

Employers frequently reported on the gap between theory and practice across skilled mid-level occupations in this sector; several managers expressed that it is more difficult to find viable candidates who have real-world experience in many job types. The combination of labor market and skill gaps has led some companies to emphasize the need for work-ready employees, rather than supporting the extent of on-the-job training periods that they have in the past. One millwright manager noted: “Companies are always trying to make due with less, which means that entry-level positions are no longer thought of as just getting a warm body in there that can show up every day. Rather, you have to come with some skills in hand, be ready to work, and have the know-how for applying them.”

Conversely, in some cases the tight labor market has compelled employers to invest more heavily in in-house training, primarily out of necessity. One lumber mill electrician supervisor reported how the lack of qualified applicants has meant that they are now more open to “hire people that are missing these skill sets and train them up.”

## Employment, Occupations and Requirements

The four natural resources sector employers who participated (Sierra Pacific, Weyerhaeuser, Yakama Nation, and Vaagen Brothers) provided information on the full range of mid-level, technically oriented occupations, following the criteria provided by the research team that

defined mid-level occupations used in this study.<sup>27</sup> These employers identified a total of 56 different job titles that met the definition at the sites they were reporting. Total employment (headcount) in all skilled mid-level occupations was 571 (refer to **Appendix 2** for the full list of occupations and employment-related data collected from employers).<sup>28</sup>

### **High-Priority Occupations**

Employers were also asked to identify up to three (3) of occupations they regarded as a high priority for employment. High-priority jobs were generally defined as occupations that are currently hard to fill due to lack of qualified applicants, skill gaps among existing employees, or because of anticipated future hiring or retirements (refer to **Table 18: High Priority Jobs in the Natural Resources Sector**).<sup>29</sup> Some of these job titles are generic (“millwright”) while others are uniquely named and specific to individual employers, but may represent many of the functions or duties of job titles that are named something different by other employers.<sup>30</sup>

### **High-Priority Natural Resources Jobs, Employment and Projections**

Most of the 12 positions identified by participating employers as high-priority jobs represent employment in skilled trades (such as Millwright or Electrician), while several are in technician-related occupations, such as Forestry or Habitat Technician (refer to **Table 18: High Priority Jobs in the Natural Resources Sector**).<sup>31</sup> The largest employment numbers are led by Millwright (with a combined total of 205), and this job title is expected to see considerable increases in new hiring and retirements over the next three years; one company reported that they expect to lose 20 percent (14) of their Millwrights over the next three years, which they intend to replace. New hiring for Electricians and Truck Drivers is also projected to be substantial; some companies reported that their reliance on contract logging and trucking may also expand over time.<sup>32</sup>

All four employers reported that it has been difficult to find qualified applicants for many of these positions because there are already labor market shortages and demand is high for qualified workers, especially millwrights, electricians and truck drivers. Some rely more heavily on contracted labor, such as log trucking, than in the past. It is instructive – and consistent with employers’ reports about labor shortages – that all three employers who employ

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<sup>27</sup> For this study, employers were asked to report technically oriented jobs that are directly tied to the primary product or services that are created and marketed by the organization, and for which the equivalent of a high school diploma (minimum) but less than a four-year college degree is generally a requirement for those jobs.

<sup>28</sup> As noted earlier, these numerical data are limited to the occupations identified by participating employers, and are primarily provided for identification and illustration. These data cannot be generalized to represent the industry as a whole.

<sup>29</sup> Some job titles, such as Millwright and Electrician, are duplicated because they represent a high-priority job that was identified by more than one employer. These data were not combined so that vacancies and forecast data for each employer remains intact.

<sup>30</sup> Because the project included large and small employers, and not all employers use the same job titles for similar jobs, the number of some common job titles may vary considerably compared to others.

<sup>31</sup> Some job titles, such as Millwright and Electrician, are duplicated because they represent a high-priority job that was identified by more than one employer. These data were not combined so that vacancies and forecast data for each employer remains intact.

<sup>32</sup> It is important to note that these occupational projections are not representative. Furthermore, there are clear discrepancies between occupational demand projections made by ESD differ significantly from that of industry. This dilemma is further explored in the Millwrights case study.

Millwrights identified them as a high-priority job type. Other employers emphasized that while some positions do not represent large employment numbers, they are critical to their operations. These jobs typically entail extensive training and require specialized skills that can take years to develop; some are technically complex and critical to properly manage and protect resources (such as many of the technician jobs).

**Table 18: High Priority Jobs in the Natural Resources Sector**

<b>Job Title</b>	<b>Employment</b>	<b>Job Vacancies</b>	<b>New Hiring, Next 3 Years</b>	<b>Retirements, Next 3 Years</b>
Millwright (company 1)	102	10	20	9
Truck Driver	93	2	10	8
Millwright (company 2)	69	2	18	14
Log Scaler/Sorters	32	0	5	4
Millwright (company 3)	34	3	5	2
Electrician (company 1)	22	8	10	2
Fish Tech II	18	3	0	0
Electrician (company 2)	8	1	2	0
Boiler/Kiln Lead	7	1	2	0
Forestry Technician	3	0	4	0
Forestry Technician IV	2	0	0	0
Sr. Habitat Technician	1	0	1	1
<b>TOTAL</b>	<b>391</b>	<b>27</b>	<b>77</b>	<b>40</b>

*Source: Employer interviews conducted by Washington State University*

The Natural Resource sector employers reported that they regularly rely on contracted employment for some job types, especially for truck drivers, and for timber harvesting positions (logging, processing). While some contracted employment is ongoing, some types represent sporadic employment that is seasonal. For instance, one company reported that they contract with outside providers for up to 120 log trucks and drivers per day. Two companies reported that they contracted externally for timber harvesting (logging, processing) and transportation (log trucking) that represents contracted employment of 140 annually. Another company interview estimated that they contract out 40-50 people employed in logging activities to harvest wood for milling. Some contractors are sole proprietors, while others are companies that hire additional employees, thus the reported number of jobs represented by contracted employment is probably a conservative estimate. Another organization regularly contracts externally for timberland services such as tree-thinning, which represents approximately 12 jobs annually. Several employers noted that they also temporarily contract for specialized technical, fabrication, consulting or construction-related work.

### **Natural Resources: Knowledge, Skills, Abilities and Pathways**

The following sections highlight data collected directly from participating employers regarding the primary knowledge, skills and abilities they regarded as important qualities for each of the high-priority occupations they identified. Interview topics included technical skills, other important knowledge, skills and abilities, formal preparation, typical entry pathways, and next-level employment (advancement).<sup>33</sup>

**Technical Skills:** Employers were also asked to describe the leading core technical skills and specific technical skills they saw as especially important to have in these high-priority jobs. The technically related knowledge, skills and abilities reported below are not meant to represent comprehensive job descriptions or requirements, but rather reflect the general topics and skill sets that these employers viewed as essential competencies for these positions.

Employers place considerable emphasis on specialized knowledge and skills required by each occupation (refer to **Table 19: Core and Specific Technical Skills by Job Title in Natural Resources**). Most of the jobs listed require mid- to long-term preparation and specific knowledge about the occupation, which typically comes from participating in apprenticeships or other structured training and experiences that include applied learning, mentoring under a journey-level worker and a strong emphasis on safety. For all positions, a need for at least limited proficiency in the use of computer technologies and basic software applications was stressed; the level of computer and technology skill clearly varies by job type and application. Technician positions show a considerable understanding of scientific concepts, methods and tools, as well as GIS and navigation and mapping software such as GPS.

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<sup>33</sup> These data were reviewed, compared and in some case supplemented through analyses of job descriptions provided by the individual companies. Web-based occupational resources such as the Bureau of Labor Statistics and electronic job postings were also used to review skills and competencies.

**Table 19: Core and Specific Technical Skills by Job Title in Natural Resources**

Job Title <sup>34</sup>	Core Technical Skills	Specific Technical Skills
Millwright (company 1)	<ul style="list-style-type: none"> <li>• Knowledge of hydraulic systems – fluid power systems</li> <li>• Knowledge of pneumatic systems</li> <li>• Can interpret prints and schematics</li> <li>• Comfortable with precision machine alignments</li> <li>• Knowledge of power transmission components: couplings between motors and reducers, mill chains, and sprockets</li> <li>• Basic fabrication</li> <li>• Understanding of lubrication and why it is important</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding of power ratios mechanized through gear reducers to achieve desired machine functioning (milling logs that vary in diameter and weight require different power ratio settings)</li> <li>• Ability to use a plasma, oxy and acetylene, gas, arch, MIG, and TIG welder machines. Aluminum welding skills is a bonus</li> <li>• Be able to cut using a grinder or die grinder</li> </ul>
Truck Driver	<ul style="list-style-type: none"> <li>• Ability to safely drive a semi-truck</li> <li>• Computer skills for evaluating truck loads</li> <li>• Use of chain or cable binders to secure load on trailer during transit</li> </ul>	<ul style="list-style-type: none"> <li>• CDL (Commercial Driver’s License) with safe driving record on public highways and logging roads</li> <li>• Navigation skills</li> </ul>
Millwright (company 2)	<ul style="list-style-type: none"> <li>• Ability to do basic service work (i.e., oil changes, hydraulic hose changes, grease machinery, etc.)</li> <li>• Welding skills</li> <li>• Can do computational division without the use of a calculator</li> <li>• Can read and interpret drawings and blueprints to fabricate equipment and make modifications</li> <li>• Knowledge of how to use hand and power tools</li> </ul>	<ul style="list-style-type: none"> <li>• Welding, fabrication, general machine assembly and machine alignment</li> <li>• Knowledge of how to work on gear boxes and drive chains</li> <li>• Knowledge of hydraulic and pneumatic systems</li> </ul>
Log Scaler/Sorters	<ul style="list-style-type: none"> <li>• Evaluate log characteristics and determine grades, using established criteria</li> <li>• Use of hand-held computer for input data</li> <li>• Strong mathematical understanding of percentages and proportions</li> </ul>	<ul style="list-style-type: none"> <li>• The ability to identify tree species and apply the appropriate grade criteria for classifying logs into their various lumber uses</li> <li>• Mastered ability to calculate board feet estimations from assorted lumber that varies in length and diameter</li> </ul>
Millwright (company 3)	<ul style="list-style-type: none"> <li>• Use hand tools, power tools, hoists, cranes, welding equipment, measuring, and testing equipment to perform maintenance and repair</li> <li>• Dismantle defective machines and equipment and install new or repaired parts, following specifications and blueprints using precision measuring instruments and hand tools</li> <li>• Can operate a cutting torch or welding equipment</li> </ul>	<ul style="list-style-type: none"> <li>• Visually inspect and test machinery and equipment, using electrical and electrical test equipment</li> <li>• Listen for unusual sounds from machines or equipment to detect malfunctions and discuss machine operation variations with supervisor or other maintenance workers to diagnose problems or repair machines</li> </ul>
Electrician (company 1)	<ul style="list-style-type: none"> <li>• Knowledge of high voltage electrical wiring (i.e., above 480 AC)</li> <li>• But also, knowledge of 480 volt three</li> </ul>	<ul style="list-style-type: none"> <li>• Computer skills required to use PLCs (Programmable Logic Controllers) – to be able to program and trouble shoot them</li> </ul>

<sup>34</sup> Some job titles, such as Millwright and Electrician, are duplicated because they represent a high-priority job that was identified by more than one employer.

	<ul style="list-style-type: none"> <li>phase and 240, 120, and 208</li> <li>• Knowledge of AC and DC motors</li> <li>• Know how electrical panels are constructed and how to lay out wires in an organized manner</li> <li>• Understanding of motion control whether it is electronically, pneumatically, or hydraulically actuated. This involves knowledge of PID (Portable Integral Derivative) loops, which are closed loops to maintain precise control over machinery functioning and proximity switches (e.g., sensors)</li> </ul>	<ul style="list-style-type: none"> <li>• Experience working with servo and hydraulic motion control and tuning</li> </ul>
Fish Tech II	<ul style="list-style-type: none"> <li>• Interest in fisheries technician work and resource management</li> <li>• Knowledge of standard fisheries principles and procedures</li> <li>• Ability to learn and perform the technical requirements of the position</li> <li>• Ability to deal tactfully with the public</li> <li>• Ability to express technical ideas effectively both orally and in writing</li> </ul>	<ul style="list-style-type: none"> <li>• Training/certification to use Electro-Shock equipment necessary for studying fish species</li> <li>• Ability to identify species by sight</li> <li>• Knowledge of fish handling methods</li> <li>• Tag and mark fish using a coded-wire tagging machine, freeze branding, or PIT (Passive Integrated Transporter) tags.</li> <li>• Operate juvenile or adult fish traps and record data such as weight, sex, length, and age.</li> <li>• Handle fish according to established guidelines.</li> <li>• Collect routine water samples and record data such as Ph, temperature, and D.O.</li> <li>• Collect, catch, and harvest data via on-site monitoring or fisherman interviews recording data such as fishing effort, catch, species, weight, sex, etc.</li> <li>• Conduct spawning ground survey by foot or boat recording data such as species, length, sex, etc.</li> </ul>
Electrician (company 2)	<ul style="list-style-type: none"> <li>• Can trouble shoot PLCs online</li> <li>• Bend conduit and pull wire</li> <li>• Can weld and fabricate</li> <li>• Capacity to learn the systems for sawmill, planer, boiler/kilns, merchandiser, and portal crane</li> <li>• Can read schematics, load calculations, and code book</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge of frequency drives Power Flex 4, 40, 525, 70, 700. 750, 1336 plus and plus 2, and soft starts</li> <li>• Programming Omron PLCs and Allen Bradley PLCs and Siemens 505/545</li> </ul>
Boiler/Kiln Lead	<ul style="list-style-type: none"> <li>• Knowledge of boiler system – fans, valves, pumps, and switches</li> <li>• Knowledge of lubrication</li> <li>• Proficiency with hand and power tools and equipment</li> <li>• Knowledge of how to operate the front-end loader auxiliary fuel system</li> <li>• Conduct regular maintenance on boilers and turbines</li> </ul>	<ul style="list-style-type: none"> <li>• Maintain and operate boiler in accordance with required standards</li> <li>• Maintain communications with kiln operators and related technical staff</li> <li>• Troubleshoot and correct upset conditions</li> </ul>
Forestry Technician	<ul style="list-style-type: none"> <li>• Basic competency of dendrology (the scientific study of trees)</li> <li>• Theoretical understanding of forest management</li> </ul>	<ul style="list-style-type: none"> <li>• Can use a Relascope for measuring slopes, tree heights, and cross-sectional areas</li> <li>• Knowledge of the Washington State forest practice laws</li> </ul>

	<ul style="list-style-type: none"> <li>• Ability to measure geometric magnitudes (lengths, areas, volumes, etc.)</li> <li>• Computer skills, specifically Microsoft programs like Outlook and possibly PowerPoint</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge of how to use a GPS</li> <li>• Knowledge of how to use ARC/INFO, a software program uses for GIS</li> </ul>
Forestry Technician IV	<ul style="list-style-type: none"> <li>• Regular computer knowledge: Word, email – spreadsheet- Beginners level excel</li> <li>• Overall knowledge of wildland fire and what the potentials are (fire potentials: how fire will react, act “fire knowledge”)</li> </ul>	<ul style="list-style-type: none"> <li>• Familiar with GIS and GPS devices and software (GIS: ArcMap - ArcGIS) (GPS: Trimble – 6000 series). Be able to make a map using GIS. A lot of this is about maps – they need to know how to read it, and at this level – produce it.</li> <li>• Working knowledge of the science of silviculture, including forest stand dynamics, silvics of tree species of Inland Northwest forests, and insect and disease patterns</li> </ul>
Sr. Habitat Technician	<ul style="list-style-type: none"> <li>• Knowledge of fleet of agricultural equipment, such as tractors, seed drills, discs, plows, sprayers, mowers, harrows, packers, etc.</li> <li>• Knowledge of a fleet of heavy construction equipment, such as tankers, dozers, loaders, road graders, 10-yard dumps, 18-wheel tractor trailer, excavator, etc.</li> <li>• Ability to safely mix and apply herbicides for weed control</li> <li>• Ability to read and understand maps, sketches, drawings, specifications and technical manuals</li> </ul>	<ul style="list-style-type: none"> <li>• Habitat management – weed control, upland and wetland management restoration</li> <li>• Install and repair barbed wire, wildlife friendly fences, and bug and pole fences</li> <li>• Assist with wildlife surveys (counting birds on a survey route)</li> <li>• Oversee application of herbicides (state pesticides permit)</li> <li>• Knowledge of basic land management and fuel maintenance (knowing how to fill and dry up a wetland)</li> <li>• Knowledge about working with fire in general</li> <li>• Knowledge about how to manage service roads (how to resurface)</li> </ul>

**Source: Employer interviews conducted by Washington State University**

**Natural Resources: Other Knowledge, Skills, and Abilities:** The physical nature of the work tasks and use of electro-mechanical equipment required of many of these jobs underscores the need to be physically fit and focused on job safety. While this is especially true for timber harvesting, transportation and production-related jobs, most of the technician jobs also require extensive fieldwork, data collection and equipment use. Many employers noted that these jobs often require travel and navigation within remote areas, and in potentially hazardous conditions and circumstances. Solid written and verbal communication skills were regularly reported as essential for most jobs, and many employers stressed the need for high levels of self-reliance, problem-solving skills, and to be organized and efficient. The ability to work in teams, supervise, and interface with managers and employees from all levels of the organization, external contractors and the public was also emphasized. For several jobs, employers stressed the ability to interact effectively with customers, contractors and other external parties, and the ability to train and mentor new employees. Personal qualities typically reported include the ability to work independently and having a good work ethic and a positive attitude (refer to **Table 20: Other Knowledge, Skills and Abilities by Job Title in Natural Resources**).

**Table 20: Other Knowledge, Skills and Abilities (KSAs) by Job Title in Natural Resources**

Job Title	Other Knowledge, Skills and Abilities
Millwright (company 1)	<ul style="list-style-type: none"> <li>• Critical thinking capacity</li> <li>• Can think independently</li> <li>• Must have a “can-do attitude”</li> </ul>
Truck Driver	<ul style="list-style-type: none"> <li>• Good work ethic and attitude</li> <li>• Punctual</li> <li>• Desire to learn</li> <li>• Safety minded</li> <li>• Verbal communication skills</li> <li>• Good people skills</li> </ul>
Millwright (company 2)	<ul style="list-style-type: none"> <li>• An understanding of one’s role as an important component of a larger system</li> <li>• Can multitask</li> <li>• Can work in teams</li> <li>• Ability to demonstrate open, honest and regular exchange of information and treat all employees with respect and dignity</li> <li>• Takes initiative to identify and solve issues and accepts personal accountability</li> <li>• Safety minded</li> </ul>
Log Scaler/Sorter	<ul style="list-style-type: none"> <li>• Verbal communication skills</li> <li>• Can work in teams</li> </ul>
Millwright (company 3)	<ul style="list-style-type: none"> <li>• Can work in teams</li> <li>• Can assist in training and mentoring of new employees</li> <li>• Good verbal communication skills</li> </ul>
Electrician (company 1)	<ul style="list-style-type: none"> <li>• Can apply knowledge of the core technical skills to troubleshoot issues when they do arise</li> <li>• Critical thinking capacity</li> <li>• Can think independently</li> <li>• Willingness to work non-typical work hours</li> </ul>
Fish Tech II	<ul style="list-style-type: none"> <li>• Verbal and written communication skills</li> <li>• Have some leadership responsibility</li> <li>• Ability to deal tactfully with the public</li> <li>• Positive attitude</li> <li>• Willingness to learn, especially from the more senior crew</li> <li>• Willingness to step in and help others crew members out</li> <li>• Ability to ask questions when something is not understood</li> </ul>
Electrician (company 2)	<ul style="list-style-type: none"> <li>• Is on time</li> <li>• Can work in teams</li> <li>• Assist in training and mentoring of new employees</li> <li>• Good verbal communication</li> </ul>
Boiler/Kiln Lead	<ul style="list-style-type: none"> <li>• Can maintain clean and orderly work station</li> <li>• Safety minded</li> <li>• Good communication skills</li> <li>• Prepare and maintain log books and records for each shift</li> <li>• Assist in training and mentoring of new employees</li> </ul>
Forestry Technician	<ul style="list-style-type: none"> <li>• Must be very physically fit – have to navigate steep, brushy terrain</li> <li>• Must have a good sense of direction – have to find way back to truck</li> </ul>
Forestry Technician IV	<ul style="list-style-type: none"> <li>• A lot of contract work, so being able to work with others</li> <li>• Can work independently</li> <li>• Good work ethic and attitude</li> <li>• Can complete tasks on schedule</li> <li>• Wants to get things done</li> <li>• Can read and interpret maps</li> <li>• Ability to supervise individuals and skills in contractual relationships</li> </ul>

Sr. Habitat Technician	<ul style="list-style-type: none"> <li>• Knowledge of supervisory principles and practices</li> <li>• Knowledge of existing traffic laws, ordinances and rules</li> <li>• Knowledge of occupational hazards and standard safety practices associated with the use of heavy equipment and machinery</li> <li>• Can organize and prioritize work assignments and projects</li> <li>• Ability to supervise and motivate crew members</li> <li>• Ability to manage and implement multiple projects over large areas of land.</li> <li>• Ability to perform a variety of manual tasks for extended periods in various weather conditions</li> <li>• Ability to prepare written reports and forms</li> <li>• Can work independently</li> <li>• Verbal and written communication skills (communicates with a wide array of individuals - biologists, tribal members, business interactions, other crews, cultural specialists, the public)</li> <li>• Calm demeanor</li> </ul>
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**Source: Employer interviews conducted by Washington State University**

**Natural Resources Formal Preparation:** Employers require a high school or equivalent degree for employment, and nearly all reported that they have additional occupation-specific requirements for entry into most positions, or upon employment. A combination of related work experience, education and training, or completion of an apprenticeship is required for employment in most positions. In some cases, specific licenses or certifications are required, such as fire certification (red card), state pesticides standards, commercial driver’s license (CDL) or other occupation or equipment-specific certifications. Indian Nations give hiring preference to qualified Tribal members when they are available (refer to **Table 21: Required Formal Preparation in Natural Resources**).

**Table 21: Required Formal Preparation in Natural Resources**

Job Title	Required Formal Preparation
Millwright (company 1)	<ul style="list-style-type: none"> <li>• No specific degree is required</li> <li>• What is important is the ability to demonstrate the skills required of the job, or the ability to learn the skills required, which is something that usually comes with practical working experience</li> </ul>
Truck Driver	<ul style="list-style-type: none"> <li>• High school degree or equivalent</li> <li>• Valid CDL with safe driving record on public highways and logging roads</li> <li>• Current DOT medical card</li> <li>• Two years of verifiable experience operating a semi-truck/trailer</li> <li>• One year verifiable experience operating a logging truck</li> <li>• Five years free of driving incident citations</li> </ul>
Millwright (company 2)	<ul style="list-style-type: none"> <li>• High school degree or equivalent</li> <li>• Two-year trade school</li> <li>• Minimum of three years millwright experience (two years can be substituted for trade school)</li> </ul>
Log Scaler/Sorter	<ul style="list-style-type: none"> <li>• High school degree or equivalent</li> <li>• Some experience as a log scaler</li> </ul>
Millwright (company 3)	<ul style="list-style-type: none"> <li>• High school degree or equivalent preferred</li> <li>• Prior experience in position or related industry, jobs or functions (maintenance)</li> </ul>
Electrician (company 1)	<ul style="list-style-type: none"> <li>• Relevant experience, technical degree, and certification is required</li> </ul>
Fish Tech II	<ul style="list-style-type: none"> <li>• High school degree or equivalent</li> <li>• Washington State Driver’s License and ability to obtain a Tribe driving permit (more than 2 tickets and you cannot be insured)</li> <li>• Once hired, employees will be sent to electro-shock training, first aid, and if working in the</li> </ul>

	<ul style="list-style-type: none"> <li>hatchery they will get a CDL</li> <li>For employees interested in data entry, the Tribe will send them to more formal IT training</li> </ul>
Electrician (company 2)	<ul style="list-style-type: none"> <li>Relevant experience, or combination of experience, training and certification</li> </ul>
Boiler/Kiln Lead	<ul style="list-style-type: none"> <li>Relevant experience or training and experience in related areas</li> </ul>
Forestry Technician	<ul style="list-style-type: none"> <li>No specific degree is required, though most applicants come in with 1-2 years of forestry school training</li> </ul>
Forestry Technician IV	<ul style="list-style-type: none"> <li>Must have a minimum of 5 years of progressively responsible technical experience relating to forestry work</li> <li>Can pass the National Wildfire Coordinating Group national standards fitness test for arduous work level</li> <li>Can pass the Washington State Pesticide requirements, with Certification in Herbicides</li> <li>Have a Red Card (fire certification)</li> <li>CDL is not required, but it is a good qualification to have</li> </ul>
Sr. Habitat Technician	<ul style="list-style-type: none"> <li>High school degree or equivalent, though an AA degree or certificate in something related to habitat management is a bonus</li> <li>3 years' experience as a work crew supervisor</li> <li>Can pass the Washington State Pesticide requirements, with Certification in Herbicides</li> <li>Have a Red Card (fire certification)</li> <li>5 years' experience operating farm and heavy machinery</li> <li>Must have a valid Washington State Driver's License with Class A CDL certification with the ability to obtain a Tribe driving permit</li> </ul>

**Source: Employer interviews conducted by Washington State University**

**Natural Resources Typical Entry Pathways:** There are some similarities among the occupations regarding entry pathways, but in general, the typical pathways into these positions follow one or more of the following approaches (refer to **Table 22: Typical Occupational Pathways in Natural**):

1. Some related experience in the job or related fields is preferred, but many employers reported that is not a requirement for entry. Technician positions provide entry points and pathways based on experience, sometimes acquired through summer employment or structured internships, which provide practical skills and experience.
2. Education and training that is directly or closely related to the skill requirements of the occupation. Employers reported that jobs such as Millwright are often filled through internal promotion from other departments, or similar maintenance or mechanically related jobs, primarily through experience and on-the-job training. Industry-recognized certifications, training or experience is the most important qualifications for external hires.

**Table 22: Typical Occupational Pathways in Natural Resources**

Job Title	Typical Pathways
Millwright (company 1)	Typically, strong candidates come in having already established some basic skills, which more typically comes with some degree of training beyond high school that specializes in trades or mechanic work. More often than not, if someone doesn't have some type of formal training or experience, we hire them as a laborer (general laborer); we have a perpetual training program (anyone can apply but the company selects top candidates) to train workers internally. Individuals can advance more rapidly than the training program is structured for if they demonstrate skills abilities.
Truck Driver	There is no prior work experience required, but related experience is preferred - someone

	with a work history, which may demonstrate accomplishment, willingness to work, etc.
Millwright (company 2)	No prior work experience is required for the entry level, though it is preferred. An individual coming out of the sawmill as a solid maintenance person can move into a millwright position because their experience with work in this setting gives them a leg up. People who are already established in the mill or other production setting have the skills they are looking for. If a person has worked in the truck shop, they have welding, diesel motor experience, hydraulic experience, etc.).
Log Scaler/Sorter	Prior work experience is not required, but preferred (3-4 years as a scaler). No typical pathways; scalers and sorters come from trucking, operations in the woods, shovel operation. It helps if the candidate has been in the woods (because they likely have more experience identifying species), but they still have a lot to learn. This is why they prefer to higher internally, because it helps to have an idea about tree species identification coming in.
Millwright (company 3)	Related work experience and technical training in related industries, areas or functions is preferred at entry. Knowledge of the industry is an advantage.
Electrician (company 1)	Typically, strong candidates come in having already established some basic skills, which more typically comes with some degree of training beyond high school that specializes in trades mechanic work. More often than not, if someone does not have some type of formal training or experience, the company hires them as a laborer (general laborer). The company has a perpetual training program (anyone can apply but the company selects top candidates) to train workers internally. Individuals can advance more rapidly than the training program is structured or if they demonstrate skills abilities.
Fish Tech II	This is the most entry-level position in Fish Culture, so often individuals come into this position straight out of high school or some sort of internal apprenticeship program. While there is no prior work experience required for this position, it does help if candidates have some verifiable work history.
Electrician (company 2)	Related work experience and technical training in related industries, areas or functions is preferred at entry. Knowledge of the industry is an advantage.
Boiler/Kiln Lead	Related work experience and technical training in related industries, areas or functions is preferred at entry. Knowledge of the industry is an advantage.
Forestry Technician	Because these positions are more seen as a stepping stone for individuals as they finish forestry school (summer work only; paid internship-level), the typical pathway is for them to join forestry school, complete 1-2 years where they acquire the necessary skills and apply to become a forestry technician.
Forestry Technician IV	The most typical way into this position is to start at the company as a Forest Tech I and progress through the levels to gain the necessary skills and experience.
Sr. Habitat Technician	The most typical pathway into this job is to start out in some of the more entry-level positions within Forestry or Habitat Management and work your way up as you gain the necessary skills and experience.

**Source: Employer interviews conducted by Washington State University**

**Natural Resources: Next-Level Employment:** All employers reported that there are pathways for advancement into other positions, and in most cases the opportunities for career advancement included vertical promotion into next-level technical positions, lateral moves into other departments, or supervisory or management jobs. Next-level jobs for some positions such as Electrician typically include exposure to production system controllers and automation technologies that may include computer software and programming. For scientific-related technician jobs, most vertical advancement is well-defined and stepwise; however, upper-level opportunities in scientific and management positions typically require completion of a relevant four-year degree (refer to **Table 23: Next-Level Employment Opportunities in Natural Resources Careers**).

**Table 23: Next-Level Employment Opportunities in Natural Resources Careers**

Job Title	Next-Level Employment Opportunities
Millwright (company 1)	More generally in the industry, millwrights have moved into more engineering type jobs; supervisor type jobs/ management jobs.
Truck Driver	Individuals can move from Truck Driver into dispatch, front-line management, supervisor (e.g. maintenance supervisor), truck manager, and/or harvest manager.
Millwright (company 2)	Once you're the lead in your department, the next step is to move into management (maintenance supervisor then maintenance manager, or department supervisor). Pay incentive is there to move up; also, as you age it becomes a relief to move into a managerial position because this work can be very physically demanding.
Log Scaler/Sorter	Many individuals do not choose to pursue next-level opportunities because of the pay incentive and overtime to stay in their position. If they want, however, they can move into a supervisor position. Could also go into quality control – working with woods people to sort logs to get them into the right location. Also, log buying positions – It helps to know species (core technical skill of a Log Scaler) in order to identify and buy logs.
Millwright (company 3)	Lead millwright positions and supervisory roles are among the next steps; possible to move laterally into other work areas.
Electrician (company 1)	Internally, electricians can move into the tech shop that focus more on computers and automation - touch screen software, assemble PLCs, work in optimization (if they have potential). Externally, there is a lot of room for advancements out of the industrial electrician position.
Fish Tech II	Fish Tech IIs can move through the levels up to a Fish Tech IV. Some have worked on their degrees while employed and eventually became biologists.
Electrician (company 2)	Advancement opportunities to do more work with controllers and advanced automation, software, programming and troubleshooting, management, and supervision.
Boiler/Kiln Lead	Possible to advance in maintenance positions or supervision with experience and additional training.
Forestry Technician	Internally, there are no next-level jobs. This specific job is viewed as a paid internship summer working opportunity that allows forestry majors to gain the necessary experience they will need to apply as a Forester after earning a 4-year degree.
Forestry Technician IV	It is possible for Forest Tech IVs to move into a Forester position without a 4-year degree. Some have gone on to become forestry contractors.
Sr. Habitat Technician	It is possible to move into higher level technical, scientist or supervisory positions with additional training and experience.

**Source: Employer interviews conducted by Washington State University**

## Environment Sector

### Industry Description

Organizations engaged in the Environment sector are found across the entire economy and industry types, ranging from public and private-sector firms, state and local government agencies, scientific and engineering consulting companies, utility organizations, and sovereign entities that manage environmental resources like timberlands and fisheries, such as Native American Tribes. Employers that regularly interact with or impact the environment, such as public and private utility companies, may have a direct role in monitoring or reducing environmental impacts, while other employers may focus on mitigating prior environmental impacts or ensuring regulatory compliance. Employers in the Environment sector are found in all regions of Washington, in urban and rural areas, and in large and small communities across the state.

Organizations in the Environment sector typically employ skilled, mid-level employees that manage, review or perform laboratory and field tests, field observations, and data collection activities; and review of environmental policies, regulations and practices to monitor and address environmental status, resources, compliance and health.

The Environment Sector is more difficult to measure and there exists some overlap in industries between it and Natural Resources. For example, Line Workers are present in both the environment and natural resources, where they are referred to as Power Line Installers. In reviewing the study design options for this sector, the research staff found that much of the employment in this sector is public as opposed to private. These industries are a mix of detail level NAICS from utilities, professional and technical services, and public administration. Industries with a NAICS code beginning with a '9' are public administration i.e. government (refer to **Table 24:** Environment Sub-industry Breakout).

**Table 24: Environment Sub-industry Breakout***Washington State, 2016 Annual Averages*

6 digit NAICS	Industry description	Avg. firms	Average annual employment	Average annual wage
541330	Engineering services	1,606	23,260	\$92,666
541620	Environmental consulting services	291	2,373	\$75,649
813312	Environment and conservation organizations	286	2,305	\$42,449
221310	Water supply and irrigation systems	1	682	\$86,248
541330	Engineering services	2	3,070	\$81,771
541712	Other physical and biological research	2	891	\$104,493
924110	Air, water, and waste program administration	2	472	\$98,250
924120	Administration of conservation programs	3	2,218	\$64,075
926130	Utility regulation and administration	3	30	\$127,279
926140	Agricultural market and commodity regulation	2	885	\$71,069
813312	Environment and conservation organizations	1	41	\$79,454
922160	Fire protection	1	9	\$62,013
924110	Air, water, and waste program administration	2	1,639	\$61,998
924120	Administration of conservation programs	5	3,594	\$56,450
926130	Utility regulation and administration	1	158	\$67,058
926140	Agricultural market and commodity regulation	9	917	\$53,397
221310	Water supply and irrigation systems	145	3,306	\$69,497
221320	Sewage treatment facilities	34	764	\$65,973
924110	Air, water, and waste program administration	11	187	\$77,199
924120	Administration of conservation programs	70	625	\$42,208
	<b>Total Environment Sector</b>	<b>2,477</b>	<b>47,424</b>	<b>\$79,698</b>

*Source: Washington State Employment Security Department, QCEW Annual Averages*

Assuming that jobs in the environment sector are largely public sector occupations, an examination of skilled mid-level government occupations by region and government-type is a reasonable approach to assessing the occupational make up of this sector. The “Percent Outside of Central Puget Sound” column serves as an indication of occupations beyond the seat of government administration and urban-centered occupations (refer to **Table 25: Top skilled mid-level Government Occupations**). Engineering, forest and conservation, and life/physical/ and social science technicians are examples of skilled mid-level government jobs that are largely found in the state’s more rural areas, and hence more likely to be field-based. Unfortunately there are few existing public data sources relevant to assessing the occupational composition of the environment sector.

**Table 25: Top Skilled Mid-level Government Occupations***Washington State, 2017*

Title	Federal	State	Local	Percent Outside of Central Puget Sound
Firefighters	320	82	7,811	50%
Engineering technicians, except drafters, all other	1,217	0	31	93%
Water and wastewater treatment plant and system operators	13	15	1,963	58%
First-line supervisors of fire-fighting and prevention workers	53	7	2,196	45%
Forest and conservation technicians	989	41	96	87%
Supervisors of construction trades and extraction workers	401	110	988	65%
Civil engineering technicians	0	398	780	63%
Operating engineers and other construction equipment operators	150	3	949	67%
Police, fire, and ambulance dispatchers	0	151	1,167	55%
Construction and building inspectors	109	206	1,291	45%
Electrical power-line installers and repairers	356	0	635	67%
Life, physical, and social science technicians, all other	643	0	53	82%
Electrical and electronics repairers	428	153	41	72%
Electrical and electronics engineering technicians	296	9	268	70%
Environmental science and protection technicians	12	3	402	66%
Mobile heavy equipment mechanics, except engines	295	0	120	64%
Power distributors and dispatchers	223	0	71	79%
Dispatchers, except police, fire, and ambulance	69	3	311	51%
Forest and conservation workers	0	177	79	74%
Heavy and tractor-trailer truck drivers	0	157	269	44%
Surveying and mapping technicians	26	0	198	62%
Computer network support specialists	0	6	255	51%
Power plant operators	0	0	149	89%
Plant and system operators, all other	156	0	39	66%
Transportation inspectors	195	83	16	40%
Maintenance workers, machinery	5	0	186	60%
Property, real estate, and community association managers	16	3	247	41%
Construction and related workers, all other	0	45	78	87%
Stationary engineers and boiler operators	18	78	55	71%
Transportation, storage, and distribution managers	182	3	231	25%
Telecomm equipment installers and repairers	9	0	210	47%

**Source: Washington State Employment Security Department**

## Employer Interviews: Environment Sector Trends

A near-universal sentiment across companies in the environmental sector was that technological advancements continue to shape the skills requirements of skilled, mid-level labor. For example, plant operators increasingly use laptop computers for real-time systems analysis in relation to the production and distribution of hydropower; forestry technicians use Geographic Information System (GIS) technology in coordination with forest surveying equipment and handheld data input devices for mapping forest sales; heavy equipment mechanics increasingly interface with computer control systems for monitoring and managing maintenance activities on hydro-project equipment; and workers in environmental protection have begun using aerial drones to monitor and research forest lands. As one resource manager noted: “Technology has expanded and changed a lot, smart phones and applications make it possible to do some really advanced work. We need people who can learn and use those technologies. Just look at the explosion in the use of aerial drones for monitoring and research. We use them too, and there’s advanced telemetry, new computer applications becoming available for this work.”

“Technology has expanded and changed a lot, smart phones and applications make it possible to do some really advanced work. We need people who can learn and use those technologies.”

Some managers noted that one consequence of technological advancements in this sector is that it can prove challenging for educators to appropriately train future trades workers coming up the pipeline.

Technology advancements also make it difficult for employers to keep up with training. As one engineering manager observed: “This is always a hurdle for us, because the demands are always changing.” Another potential downside is over-reliance on technology: While innovations such as GPS and GIS technology allows forestry and conservation techs to spend less time in the field, this can increase the potential for them to become disconnected from direct field observations, data collection and environmental events that can be important to resource management and conservation. Because technology can fail, employees ranging from electrical line workers to forest techs also need to master basic navigation skills (map and compass reading) to safely find their way through vast forestlands and rural areas, in all weather conditions.

## Employment, Occupations and Requirements

The four environment-sector employers who participated (Quinault Nation, Tacoma Power, Grant Public Utility District and County of Spokane) provided information on the full range of skilled mid-level, technically oriented occupations, following the criteria provided by the research team that defined mid-level occupations used in this study.<sup>35</sup> These employers identified a total of 76 different job titles that met the definition at the sites they were reporting. Total employment (headcount) in all skilled mid-level occupations was 477 (refer to

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<sup>35</sup> For this study, employers were asked to report technically oriented jobs that are directly tied to the primary product or services that are created and marketed by the organization, and for which the equivalent of a high school diploma (minimum) but less than a four-year college degree is generally a requirement for those jobs.

Appendix 2 for the full list of occupations and employment-related data collected from employers).<sup>36</sup>

### High-Priority Occupations

Employers were also asked to identify up to three (3) of occupations they regarded as a high-priority for employment. High priority jobs were generally defined as occupations that are currently hard to fill due to lack of qualified applicants, skill gaps among existing employees, or because of anticipated future hiring or retirements (refer to **Table 26: High Priority Jobs in the Environment Sector**). Some of these job titles are generic (“engineering technician”) while others are uniquely named and specific to individual employers, but may represent many of the functions or duties of job titles that are named something different by other employers.<sup>37</sup>

### High-Priority Environment Jobs, Employment and Projections

**Table 27** shows that nearly all of the 14 positions identified by participating employers as high-priority jobs represent employment in skilled trades (line worker, electrician, mechanic, operator) or in technician-related occupations, such as engineering or water quality technicians. The largest employment numbers, led by line worker, reflect the inclusion of two public utilities in this sector. Several of the utility jobs are expected to see proportional increases in new hiring, especially Sr. Line Electricians. Several of the utility positions will also experience a substantial number of retirements over the next three years, which is generally consistent with reported retirement trends for the utility industry as a whole.

Many employers reported that it has been difficult to find qualified applicants for these positions because there are already labor market shortages and demand is high for qualified workers. Many noted that these jobs entail extensive training and specialized skills that take years to develop (such as most utility jobs), and/or they are relatively unique and do not comprise large numbers of jobs, but are technically complex and critical to properly managing and protecting resources (such as many of the technician jobs).

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<sup>36</sup> As noted earlier, these numerical data are limited to the occupations identified by participating employers, and are primarily provided for identification and illustration. These data cannot be generalized to represent the industry as a whole.

<sup>37</sup> Because the project included large and small employers, and not all employers use the same job titles for similar jobs, the number of some common job titles may vary considerably compared to others.

**Table 26: High Priority Jobs in the Environment Sector**

Job Title	Employment	Job Vacancies	New Hiring, Next 3 Years	Retirements, Next 3 Years
Line Worker	42	3	5	5
Power Plant Operator	37	1	6	6
Engineering Technician 3	21	1	6	6
Sr. Line Electrician	17	4	12	8
Heavy Equipment Mechanic	14	1	6	5
Systems Operator	11	0	3	3
Hydro Project Mechanic	9	1	6	5
Engineering Technician 2	9	2	3	4
Forest Practice Technician	4	0	0	0
Water Quality Technician	3	0	0	0
Natural Resources Intern	2	1	0	0
Clerk	2	1	1	0
Cedar Recovery Technician	1	2	2	0
Pre-Sales Tech	0	1	2	0
<b>TOTAL</b>	<b>172</b>	<b>18</b>	<b>49</b>	<b>39</b>

*Source: Employer interviews conducted by Washington State University*

### Contracted Employment

The four Environment sector employers reported that they do not regularly rely on contracted employment for mid-level technical work. Utility employers reported that they do sometimes rely on temporary contracted employment to respond to unusual circumstances, such as during storms that cause power outages and require additional line workers to quickly restore electrical service. More common is that these employers will hire students for a limited number of summer or seasonal high school or college intern positions within one or more departments. Employers noted that this approach enables them to stimulate career interest among students in local communities, schools and colleges. This enables students to develop applied job skills and experience that make them competitive in the job market, while helping employers generate a local future applicant pool for regular position openings as they become available.

### Environment: Knowledge, Skills, Abilities and Pathways

The following sections highlight data collected directly from participating employers regarding the primary knowledge, skills and abilities they value as important qualities for each of the high-priority occupations they identified. Interview topics included technical skills, other important knowledge, skills and abilities, formal preparation, typical entry pathways, and next-level employment (advancement).<sup>38</sup>

<sup>38</sup> These data were reviewed, compared and, in some case, supplemented through analyses of job descriptions provided by the individual companies. Web-based occupational resources such as the Bureau of Labor Statistics and electronic job postings were also used to review skills and competencies.

**Technical Skills:** Employers were also asked to describe the leading core technical skills and specific technical skills they saw as especially important to have in these high-priority jobs. The technically related knowledge, skills and abilities reported below are not meant to represent comprehensive job descriptions or requirements, but rather reflect the general topics and skill sets that these employers viewed as essential competencies for these positions.

Employers place considerable emphasis on specialized knowledge and skills required to perform work requirements in each occupation (refer to **Table 27: Core and Specific Technical Skills by Job Title in Environment**). Utility-related occupations in particular require long-term preparation and specific knowledge about electrical theory and applied experience that comes from participation in apprenticeships, which stress applied learning and mentoring, and a strong emphasis on safety. For all positions, a need for proficiency in the use of computer technologies and software applications was stressed; this is especially evident in engineering technician positions, but employers noted that the need for computer skills extends to all of these jobs. Even positions related to administrative work require specialized technical knowledge and related financial skills that were reported as essential to qualification. For technician jobs, mapping and GIS skills were often mentioned. Basic engineering skills were also named as important for several jobs.

**Table 27: Core and Specific Technical Skills by Job Title in Environment Sector**

Job Title	Core Technical Skills	Specific Technical Skills
Line Worker	<ul style="list-style-type: none"> <li>• Reading a print or map (one-line drawings) to decipher engineering instructions</li> <li>• Volt meter (high and low) 600 volts to 120 (in residential homes); high voltage 500,000 volts to 7,000 volts</li> <li>• Use a rotation meter</li> <li>• Can use climb plyers (used to cut a conductor up to number 4 ACSR)</li> <li>• Familiar with a multitude of presses, dies, and pressers</li> <li>• Batter operated drills and pressers</li> <li>• Math for calculating feet of wire</li> </ul>	<ul style="list-style-type: none"> <li>• Hot sticking methods and procedures (6ft fiberglass sticks for engaging powerlines with tools)</li> <li>• Comply with WAC – Electrical Safety Standards, Administration and Installation</li> <li>• Mastery of transformer connections (ex: take 7000 volts down to a usable voltage for residential use)</li> </ul>
Power Plant Operator	<ul style="list-style-type: none"> <li>• Computer skills (Microsoft suite)</li> <li>• Ability to use and operate a centralized maintenance tracking system</li> <li>• Knowledge of coil windings vs rotation</li> <li>• Knowledge of sine waves (AC sine waves)</li> <li>• Ability to pass respirator fit-testing and training (climbing up-stairs, ladders)</li> </ul>	<ul style="list-style-type: none"> <li>• Advanced knowledge and understanding of power generation and power plant equipment</li> <li>• Knowledge of electrical and mechanical theory, thermal dynamics, and the fundamentals of AC and DC electrical systems</li> <li>• Know how megavars (reactive power) are used to deliver Megawatts (active power)</li> <li>• Knowledge of fluid dynamics –calculate the total flow rate passing through turbines to get a desired torch for generating power</li> <li>• Have a systems perspective of power generation – understand the mechanisms</li> </ul>

		and their implications for managing the power grid
Engineering Technician 3	<ul style="list-style-type: none"> <li>• Basic familiarity with engineering and surveying principles</li> <li>• Accurately measure environment to correctly establish project scale</li> <li>• Conduct routine checks on project specifications</li> <li>• Grasp whole scope of a project and incorporate this understanding into work and decision making</li> </ul>	<ul style="list-style-type: none"> <li>• 3D design using AutoCAD Autodesk for designing road construction projects</li> <li>• Incorporate survey data into designs in order to calculate volumes of materials required to make or repair a road</li> </ul>
Sr. Line Electrician	<ul style="list-style-type: none"> <li>• Methods, equipment and materials used in the construction, maintenance and repair of electrical overhead and underground lines, cables and equipment</li> <li>• Principles of electrical theory and application to electrical overhead and underground circuits and systems</li> <li>• Rigging methods and hoisting procedures</li> <li>• Read and interpret blueprints, shop drawings, sketches, circuit diagrams, system maps and underground lay-outs</li> </ul>	<ul style="list-style-type: none"> <li>• Occupational hazards and safety procedures associated with work on or around energized high-tension utility power lines, cables and equipment</li> </ul>
Heavy Equipment Mechanic	<ul style="list-style-type: none"> <li>• Understanding of the methods, equipment, and materials used in the overhaul, repair, and maintenance of heavy diesel and gas equipment and vehicles</li> <li>• Operation and care of internal combustion engines, chassis, parts and replacements</li> <li>• Knowledge of ignition, electrical, and cooling systems, fuel injection systems, ABS brake systems, and heating and air conditioning systems</li> <li>• Knowledge of hydraulic, electric, and air breaks</li> <li>• Metal fabrication, welding, painting, and body work</li> </ul>	<ul style="list-style-type: none"> <li>• Computer skills for troubleshooting mechanical issues</li> <li>• Use specialized equipment and software to diagnose, test equipment, gather data to monitor machine functioning</li> </ul>
Systems Operator	<ul style="list-style-type: none"> <li>• Understanding of the methods for monitoring electrical system conditions in order to anticipate and mitigate potentially dangerous and costly system problems</li> <li>• Knowledge of all system components and reliability factors, potential disturbances, response options and impacts</li> <li>• Knowledge of key personnel and departments required to help diagnose and isolate system disturbances, response options and implement solutions</li> </ul>	<ul style="list-style-type: none"> <li>• Ability to operate, monitor and act on information through a complex set of computer consoles within a control center</li> <li>• Must quickly and systematically assess system disturbances and events and respond to restore power grid to safe operating conditions</li> <li>• Perform under stressful conditions</li> </ul>
Hydro Project Mechanic	<ul style="list-style-type: none"> <li>• Methods, equipment, and materials used in mechanical maintenance and repair, construction, carpentry, plumbing, air conditioning/heating, and basic electric</li> <li>• Operate and maintain lathes, mills, drills, and common machine shop tools and equipment</li> </ul>	<ul style="list-style-type: none"> <li>• Interpret and apply the principles of mechanics, fluids and hydraulics as they are used in power generation and associated equipment</li> <li>• Obtain and maintain safety clearances on rotating equipment for maintenance purposes</li> </ul>

	<ul style="list-style-type: none"> <li>• Prepare and use rigging for lifting heavy loads by crane or portable equipment</li> <li>• Metal welding and cutting skills</li> <li>• Prepare and work from blueprints, shop drawings, and sketches</li> <li>• Computer skills for documentation and communication</li> </ul>	
Engineering Technician 2	<ul style="list-style-type: none"> <li>• Basic familiarity with engineering and surveying principles</li> <li>• Accurately measure environment to correctly establish project scale</li> <li>• Conduct routine checks on project specifications</li> </ul>	<ul style="list-style-type: none"> <li>• 2D design using AutoCAD Autodesk for designing road construction projects</li> </ul>
Forest Practice Technician	<ul style="list-style-type: none"> <li>• Mapping skills using Arc GIS</li> <li>• Interact with databases</li> <li>• Understanding of nature and the cultural interaction with it</li> <li>• Basic computer skills</li> </ul>	<ul style="list-style-type: none"> <li>• Use Arc GIS to mark property lines, logging areas, riparian zones (measurement is crucial)</li> <li>• Translate data and information to different audiences in some detail</li> <li>• Basic wilderness navigation – can use a compass and GPS</li> </ul>
Water Quality Technician	<ul style="list-style-type: none"> <li>• Mapping skills using Arc GIS</li> <li>• Interact with databases</li> <li>• Understanding of nature and the cultural interaction with it</li> <li>• Basic computer skills</li> <li>• Basic science skills –scientific method and data collection</li> </ul>	<ul style="list-style-type: none"> <li>• Basic wilderness navigation – can use a compass and GPS</li> <li>• Follow Federal (EPA) protocol for data collection of water sources</li> </ul>
Natural Resources Intern	<ul style="list-style-type: none"> <li>• Computer skills (Office suite) – basic data entry and writing</li> <li>• Mapping skills using Arc GIS</li> <li>• Basic science and analysis skills</li> </ul>	<ul style="list-style-type: none"> <li>• GIS/GPS</li> <li>• Translate data and information to different audiences in some detail</li> <li>• Basic wilderness navigation – can use a compass and GPS</li> </ul>
Clerk	<ul style="list-style-type: none"> <li>• Computer skills for data entry and computerized record keeping</li> <li>• Math: fractions and percentages</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge and understanding of how to interact with a database</li> <li>• Knowledge of TAAMS (Trust Asset Accounting Management System)</li> </ul>
Cedar Recovery Tech	<ul style="list-style-type: none"> <li>• Knowledge of forestry practices</li> <li>• Use hand-held data recorders</li> <li>• Mapping skills using Arc GIS</li> <li>• Use range finder for measuring tree height</li> <li>• Use diameter tapes for measuring tree diameter</li> </ul>	<ul style="list-style-type: none"> <li>• Set initial timber sale boundaries using aerial photography</li> <li>• Use Ralskope to calculate volume of timber sale plots</li> <li>• Establish minor forest products (cedar recovery of downed lumber) pre-sales in accordance to Tribal policy</li> <li>• Evaluate lumber quality by assessing rot, knots, grain (straight or twisted)</li> </ul>
Pre-Sales Tech	<ul style="list-style-type: none"> <li>• Knowledge of forestry practices</li> <li>• Use hand-held data recorders</li> <li>• Mapping skills using Arc GIS</li> <li>• Use range finder for measuring tree height</li> <li>• Use diameter tapes for measuring tree diameter</li> </ul>	<ul style="list-style-type: none"> <li>• Set initial timber (standing) sale boundaries using aerial photography</li> <li>• Use Ralskope to calculate volume of timber sale plots</li> <li>• Establish timber pre-sales in accordance to Tribal policy</li> </ul>

**Source: Employer interviews conducted by Washington State University**

**Environmental: Other Knowledge, Skills, and Abilities:** The physical nature of the work tasks required of many of these jobs underscores the need to be physically fit, coordinated and with good safety awareness. While this was especially true for utility-related jobs, most of the technician jobs also require extensive fieldwork, data collection, travel and navigation within remote areas and in potentially hazardous conditions that require high levels of self-reliance and initiative. For all jobs, employers placed great emphasis on critical thinking and problem-solving skills, as well as solid communications skills, including the ability to work in teams, and interface with managers and employees from all levels of the organization. For several jobs, employers stressed the ability to listen and interact effectively with customers, contractors and other external parties. Being flexible, adaptable, reliable, and willing to work independently were among the personal qualities emphasized by many employers (refer to **Table 28: Other KSAs by Job Title in Environment**).

**Table 28: Other Knowledge, Skills and Abilities by Job Title in Environment Sector**

<b>Job Title</b>	<b>Other KSAs</b>
Line Worker	<ul style="list-style-type: none"> <li>• Can climb – physically fit</li> <li>• good verbal communication (always two people doing hot sticking)</li> <li>• Coordinated</li> <li>• Can't be afraid of heights</li> <li>• Adaptable</li> <li>• Can collaborate in teams</li> </ul>
Power Plant Operator	<ul style="list-style-type: none"> <li>• Cannot being color blind</li> <li>• Willing to work rotating shift work</li> <li>• Flexibility</li> <li>• Problem solving abilities</li> <li>• Critical thinking abilities</li> <li>• Maintain confidential records and logs that include regulatory compliance as well as environmental compliance</li> <li>• Good verbal and written communication skills</li> <li>• Can work independently</li> <li>• Has good judgement</li> <li>• Safety minded</li> </ul>
Engineering Technician 3	<ul style="list-style-type: none"> <li>• Verbal and written communication skills</li> <li>• Can work independently</li> <li>• Can schedule workload independently</li> <li>• Can prioritize</li> </ul>
Sr. Line Electrician	<ul style="list-style-type: none"> <li>• Lift heavy objects in awkward and confined spaces using proper lifting and rigging techniques</li> <li>• Climb power poles, towers and other structures in varying weather conditions</li> <li>• Follow proper procedures for handling hazardous and toxic substances</li> <li>• Verbal and written communication skills</li> <li>• Read, interpret, apply and explain laws, codes, rules, regulations, policies and procedures</li> <li>• Maintain records and prepare reports</li> <li>• Can lead and work in teams</li> <li>• Analyze situations accurately and adopt an effective course of action</li> </ul>
Heavy Equipment Mechanic	<ul style="list-style-type: none"> <li>• Verbal and written communication skills</li> <li>• Maintain simple records and repair reports</li> <li>• Can work in teams</li> <li>• Analyze situations accurately and adopt an effective course of action</li> <li>• Perform heavy manual labor</li> <li>• Meet schedules and timelines</li> <li>• Understand and follow written and oral direction</li> <li>• Provide work direction to others</li> </ul>

Systems Operator	<ul style="list-style-type: none"> <li>• Ability to accurately assess system disturbances and determine solutions</li> <li>• Ability to work under time pressure and stressful conditions</li> <li>• Shiftwork with long hours required</li> <li>• Read, interpret, apply and explain laws, codes, rules, regulations, policies and safety and security procedures</li> <li>• Critical thinking and problem solving</li> <li>• Teamwork, communications and social skills</li> </ul>
Hydro Project Mechanic	<ul style="list-style-type: none"> <li>• Can interpret and apply health and safety regulations</li> <li>• Can interpret and apply applicable laws, codes, regulations, policies, and procedures</li> <li>• Basic First Aid and CPR</li> <li>• Verbal and written communication skills</li> <li>• Analyze situations accurately and adopt an effective course of action</li> <li>• Can work independently with little direction</li> <li>• Can work in teams</li> <li>• Prepare and present accurate and reliable reports containing findings and recommendations</li> </ul>
Engineering Technician 2	<ul style="list-style-type: none"> <li>• Verbal and written communication skills</li> <li>• Can work independently</li> <li>• Can schedule workload independently</li> <li>• Can prioritize</li> </ul>
Forest Practice Technician	<ul style="list-style-type: none"> <li>• Decision making skills</li> <li>• Communication skills</li> <li>• Conflict resolution</li> <li>• Good listening skills</li> <li>• Social and negotiation skills</li> <li>• Can enforce policy related forest practices</li> <li>• Basic driving/off-road skills – navigate, travel safely, and conduct basic vehicle maintenance like change tires.</li> </ul>
Water Quality Technician	<ul style="list-style-type: none"> <li>• Can read and interpret directions</li> <li>• Can work independently</li> <li>• Critical thinking and problem-solving skills</li> <li>• Good listening skills</li> <li>• Adaptable</li> <li>• Navigate</li> <li>• Off-road skills</li> <li>• Can hike in streams</li> <li>• Attention to detail</li> <li>• Reliable</li> <li>• Detail oriented</li> </ul>
Natural Resources Intern	<ul style="list-style-type: none"> <li>• Multi-task</li> <li>• Good listening skills</li> <li>• Professionalism</li> <li>• Engage with the overarching goals of the company</li> <li>• Safety minded</li> <li>• Adaptable</li> <li>• Can ask questions</li> <li>• Responsive</li> <li>• Humility</li> </ul>
Clerk	<ul style="list-style-type: none"> <li>• Experience in accounting</li> <li>• Practices and concepts of business management</li> <li>• Strong English skills (grammar and punctuation)</li> <li>• Verbal and written communication skills</li> <li>• Can work in teams</li> <li>• Friendly personality; personable</li> <li>• Can cross train to other duties for coverage</li> </ul>

	<ul style="list-style-type: none"> <li>• Takes initiative to learn other skills and abilities</li> </ul>
Cedar Recovery Tech	<ul style="list-style-type: none"> <li>• Can work in teams</li> <li>• Friendly personality; personable</li> <li>• Can cross train to other duties for coverage</li> <li>• Takes initiative to learn other skills and abilities</li> <li>• Good attitude</li> <li>• Take initiative</li> </ul>
Pre-Sales Tech	<ul style="list-style-type: none"> <li>• Can work in teams</li> <li>• Friendly personality; personable</li> <li>• Can cross train to other duties for coverage</li> <li>• Takes initiative to learn other skills and abilities</li> <li>• Good attitude</li> <li>• Take initiative</li> </ul>

**Source:** Employer interviews conducted by Washington State University

**Environmental: Formal Preparation:** All employers require a high school or equivalent degree for employment, and nearly all reported that they have additional occupation-specific requirements for entry into most positions. Related work experience, education and training, or some combination of experience and training is required for employment in most positions. In some cases, specific licenses or certifications are required, such as the ASE (Automotive Service Excellence) certificate, and other industry, occupation or equipment-specific certifications are sometimes required as a condition of employment or continued employment. Many of these jobs require a current driver's license. Indian Nations give hiring preference to qualified Tribal members when they are available (refer to **Table 29:** Required Formal Preparation in Environment).

**Table 29: Required Formal Preparation in Environment Sector**

Job Title	Required Formal Preparation
Line Worker	<ul style="list-style-type: none"> <li>• Natural progression from apprentice in terms of hours in classroom and in the field</li> <li>• Once the apprenticeship program is completed and three supervisors agree to further progress to journeyman status, a final exam is required</li> </ul>
Power Plant Operator	<ul style="list-style-type: none"> <li>• Graduation from high school or equivalent and come from a science and math background</li> <li>• Often, individuals are recruited directly from the Naval Nuclear Power Program (60% are ex-Navy)</li> </ul>
Engineering Technician 3	<ul style="list-style-type: none"> <li>• High school degree (or GED equivalent)</li> <li>• A driver's license; and a total of two years combined field experience and/or school or vocational training. Regarding the two years of experience, this is often acquired through internships, summer help positions, or additional schooling that is directly related to the engineering field.</li> </ul>
Sr. Line Electrician	<ul style="list-style-type: none"> <li>• Graduation from high school, or equivalent, and 3 years' experience as a Line Electrician with the company or a combined total of five years' experience working as a journey level Line Electrician with a minimum of two years' continuous experience as a Line Electrician with the company</li> <li>• Valid journey-level card</li> <li>• Valid Washington State Class A Commercial Driver's License</li> <li>• Valid First Aid and CPR Certificate</li> <li>• Valid Traffic Control Flagging Card</li> <li>• Valid forklift certification at time of appointment and maintained thereafter</li> </ul>
Heavy Equipment Mechanic	<ul style="list-style-type: none"> <li>• Graduation from high school or equivalent and one of the following: Four or more years' experience in the repair, overhaul and maintenance of a variety of light, medium and heavy-duty vehicles and heavy power-driven equipment and one of the following: <ul style="list-style-type: none"> <li>○ Completion of recognized automotive machinist apprenticeship program, or</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>○ ASE Master Automobile or Medium/Heavy Truck Technician Certification, or</li> <li>○ Graduation from an automotive or truck mechanic vocational program; or eight or more years' experience in the repair, overhaul and maintenance of a variety of light, medium and heavy-duty vehicles and heavy power-driven equipment.</li> </ul>
Systems Operator	<ul style="list-style-type: none"> <li>● Graduation from high school or equivalent and successful completion of one or more apprentice programs in electrical field, or equivalent electrical education or experience</li> </ul>
Hydro Project Mechanic	<ul style="list-style-type: none"> <li>● Graduation from high school or equivalent, valid driver's license and one of the following: <ul style="list-style-type: none"> <li>○ Three years training in industrial mechanical maintenance and three of the last five years' experience as a journey-level mechanic involving industrial mechanical and maintenance duties; OR</li> <li>○ Completion of a recognized mechanical apprenticeship program and three of the last five years' experience as a journey-level mechanic involving industrial mechanical and maintenance duties; OR</li> <li>○ A minimum of two of the last five years as a journey-level mechanic/machinist at a hydroelectric generating station; OR</li> <li>○ A current employee/Utility Worker who has a minimum of three years documented experience as a journey-level mechanic performing industrial mechanical and maintenance duties.</li> </ul> </li> </ul>
Engineering Technician 2	<ul style="list-style-type: none"> <li>● High school degree (or GED equivalent)</li> <li>● A driver's license</li> <li>● A total of two years combined field experience and/or school or vocational training. Regarding the two years of experience, this is often acquired through internships, summer help positions, or additional schooling that is directly related to the engineering field.</li> </ul>
Forest Practice Technician	<ul style="list-style-type: none"> <li>● Graduation from high school, with a preference for local/cultural knowledge about engaging with the environment – hunting, fishing, foraging for plants – when growing up</li> <li>● 2-year forest management degree preferred but not required. Preference to Tribal members</li> </ul>
Water Quality Technician	<ul style="list-style-type: none"> <li>● Graduation from high school, with a preference for local/cultural knowledge about engaging with the environment – hunting, fishing, foraging for plants – when growing up</li> <li>● 2-year forest management degree preferred but not required. Preference to Tribal members</li> </ul>
Natural Resources Intern	<ul style="list-style-type: none"> <li>● Graduation from high school, with a preference for someone who is enrolled in a college program in natural resources, or something related</li> </ul>
Clerk	<ul style="list-style-type: none"> <li>● Graduation from high school and 3 years' experience with clerical office work, preferably some experience interfacing with a database</li> <li>● Preference to Tribal members</li> </ul>
Cedar Recovery Tech	<ul style="list-style-type: none"> <li>● Graduation from high school, or equivalent, with a preference for working experience</li> <li>● Preference to Tribal members</li> </ul>
Pre-Sales Tech	<ul style="list-style-type: none"> <li>● Graduation from high school and 3 years' experience managing forestry resources.</li> <li>● Preference to Tribal members</li> </ul>

**Source: Employer interviews conducted by Washington State University**

**Environmental: Typical Entry Pathways:** There are some similarities among the occupations regarding entry pathways (refer to **Table 30: Typical Occupational Pathways in Environment**). In general, however, the typical pathways into these positions follow one or more of the following approaches:

1. Experience in the occupation, or in related employment, that provides sufficient background and knowledge to qualify for employment in the position.

2. Acquisition of relevant experience through summer employment or structured internships, which provide practical skills and experience with the technical and administrative characteristics of the work and the employer. This was common among some technician positions.
3. Education and training that is directly or closely related to the skill requirements of the occupation, including apprenticeships, college or technical program degrees, or related industry-recognized licenses or certifications. Apprenticeship and prior employment in specific technical jobs is the normal pathway for the identified utility jobs.

**Table 30: Typical Occupational Pathways in Environment Sector**

<b>Job Title</b>	<b>Typical Pathways</b>
Line Worker	Apprenticeship with company that prepares individuals to take journeyman’s exam. Another natural progression is to go to line school, become a groundman or apprentice and move through the program. Alternatively, individuals can go to line school and work in a related industry before moving to groundman or apprenticeship.
Power Plant Operator	Graduation from high school or equivalent, join the Navy (power generation or management work), and follow formalized recruiting process.
Engineering Technician 3	The typical pathway for entrance into the ET3 position is from the ET2 position.
Sr. Line Electrician	Advancement from regular line electrician positions. Apprenticeship qualifies line workers to move into senior line positions over time and with proven experience.
Heavy Equipment Mechanic	A typical pathway is to graduate high school, go to vocational/community college/ or some other kind of trade mechanic school, enter the mechanical industry somewhere else (Jiffy Lube or comparable) to acquire the hands-on technical experience required for success as a Heavy Equipment Mechanic.
Systems Operator	Completion of one or more apprentice programs in the electrical field, or equivalent electrical education or experience.
Hydro Project Mechanic	Within this utility, heavy equipment mechanics and utility workers have provided a pathway to the hydro project mechanic position. Regarding the utility worker position, this role does a broad range of different tasks – truck drivers, equipment operators, carpenters – but because the pay for this role is so competitive it tends to often attract mechanics. More typically, people move into this position from outside the company. This pathway typically looks like the following: graduate high school, attend some sort of machinist program, land some sort of industrial trade mechanic job, and do that job (or a combination of other related jobs) for a minimum of 4 to 5 years. This would make someone very attractive for the hydro project mechanic position.
Engineering Technician 2	The typical pathway for the ET2 position is for individuals to have worked with another agency in the engineering field for a minimum of two years’ work (or school) experience in engineering, construction, and drafting with AutoCAD (Autodesk). Sometimes candidates come into these positions internally following temporary (seasonal) work/programs (ET1).
Forest Practice Technician	Having past experience is ideal, and it is helpful to have been an intern because it provides an opportunity to showcase the skills growth and chemistry working with the group.
Water Quality Technician	Having experience is ideal, and it is helpful to have been an intern because it provides an opportunity to showcase the skills growth and chemistry working with the group.
Natural Resources Intern	Individuals typically come into this role having been a tribal member enrolled in a 4-year degree in natural resources, or related field.
Clerk	A typical path is an internal route whereby qualified individuals already work for the tribe doing administrative work and have the skills to transfer over. Externally, individuals working in accounting or administrative work could have the skill set.
Cedar Recovery Tech	A typical path after high school would be to work for another contractor in forestry sales. Alternatively, the tribe does offer other low-level jobs that can provide individuals

	(preference for tribal members) with the necessary experience. Another alternative would be to get an AA degree in forest management.
Pre-Sales Tech	A typical path after high school would be to work for another contractor in forestry sales. Alternatively, the tribe does offer other low-level jobs that can provide individuals (preference for tribal members) with the necessary experience. Another alternative would be to get an AA degree in forest management.

**Source: Employer interviews conducted by Washington State University**

**Environment: Next-Level Employment:** All employers reported that there are pathways for advancement into other positions, and in most cases the opportunities for career advancement included vertical promotion into next-level technical positions, or into some supervisory or management occupations. Four-year degrees are required for advancement into many of these next-level jobs, however. This is especially true for positions such as scientist, hydrologist, forester and some management positions. Lateral advancement into other departments such as administration, finance, shipping or other functional or technical areas are also possible. In some cases, especially in smaller companies, the number of senior-level positions is limited, and advancement opportunities are more available outside of technical positions or are found by pursuing employment opportunities at other companies or industries (refer to **Table 31: Next-Level Employment Opportunities in Environment Careers**).

**Table 31: Next-Level Employment Opportunities in Environment Careers**

<b>Job Title</b>	<b>Next-Level Employment Opportunities</b>
Line Worker	Once a person becomes a lineman, over time, one can move into a foreman position. After foreman, the pay goes down in hour (servicemen), but goes up in the amount of overtime. Another path is to move from foreman to general foreman then superintendent. Linemen trained in the Northwest can literally pick where they want to live and the jobs are there.
Power Plant Operator	After 6 years, individuals can move into a Senior Operator (more responsibilities) position, which is followed by Chief Operator (first line leadership). They can then move into Operations Supervisor and then Plant Management positions. Candidates must have plant operations experience to do any of the upper-level management work.
Engineering Technician 3	Employees working in the ET3 position can be promoted into a project manager position. Project managers manage multiple projects at once and can involve administration work in construction. Anything above a project manager would require a 4-year college degree.
Sr. Line Electrician	Opportunity to advance into a foreman position, or to leverage technical knowledge and experience to move into supervisory or management positions.
Heavy Equipment Mechanic	The most typical next-level jobs are managers or supervisors. One unique mobility opportunity within the company is a lateral transfer. The company offers in-house apprentice school training that allows HEM to transfer to the lineman position, for example.
Systems Operator	Opportunity to advance into a Sr. Systems operator or affiliated SysOp positions, or to leverage technical knowledge and experience to move into supervisory or management positions.
Hydro Project Mechanic	Hydro Project Mechanics can be promoted to Hydro Project Assistant Manager within the city, or a Project Manager position.
Engineering Technician 2	Employees working in the ET2 position can eventually be promoted into a Project Manager position, but this usually occurs after having worked as an ET3. Project managers manage multiple projects at once and can involve administration work in construction. Anything above a project manager would require a 4-year college degree.
Forest Practice Technician	There is not a lot of mobility without continued education/training. It is possible to move into job openings internally in other departments. It is difficult to advance past this position

	without a 4-year degree.
Water Quality Technician	There is not a lot of mobility without a 4-year degree, though pay has improved for this position.
Natural Resources Intern	This job is seen as training for a 4-year degree position like biologist, hydrologist or forester.
Clerk	From this position, individuals can move into other management positions within the tribe.
Cedar Recovery Tech	There are three levels within this position. After progressing through all three, individuals can move into an entry-level professional position, such as timber sale administration. It is difficult to advance past entry-level professional without a 4-year degree.
Pre-Sales Tech	There are three levels within this position. After progressing through all three, individuals can move into an entry-level professional position, such as timber sale administration. It is difficult to advance past entry-level professional without a 4-year degree.

*Source: Employer interviews conducted by Washington State University*

## Outdoor Recreation Sector

### Industry Description

It is estimated that more than 144 million Americans— nearly half of the U.S. population — participate in activities such as hiking, fishing, skiing, rafting and biking, making outdoor recreation a big business.<sup>39</sup> The Outdoor Industry Association (OIA) estimates that the outdoor recreation economy generates \$887 billion in consumer spending annually and employs 7.6 million people.<sup>40</sup> In its examination of outdoor recreation in Western states, the OIA estimated that nearly nine percent (9%) of consumer spending generated in Washington goes to outdoor recreation activities. A related economic analysis concluded that Washingtonians, on average, spend 56 days a year recreating outdoors, which contributed to \$21.6 billion dollars in annual expenditures.<sup>41</sup> This total does not include equipment expenditures (which total \$8,974,243,000), or events occurring on public lands, (\$1,986,000 in expenditures). The report also estimated that nearly 200,000 jobs are directly or indirectly supported in Washington by outdoor recreation spending, including full-time and part-time jobs in hospitality related sectors alone, such as food and beverage services, retail, and general recreational services. Employers range from small local shops to large retailers across the state.

Of the four sectors we examined for this report, the outdoor recreation sector has the least publically available data. This is primarily because the outdoor recreation sector is not well-defined or recognized by existing industry classifications, such as NAICS, either as a first-level industry or sub-industry. Instead, most independent studies of outdoor recreation have integrated data from multiple classifications and industry categories. For this analysis, a composite table was constructed using 6-digit NAICS industries that could arguably be considered as part of “the outdoor recreation sector.” Combined, these industries had an

<sup>39</sup> Center for American Progress: “Outdoor Recreation Is Big Business: A State Scorecard and Policy Menu for Growing the Outdoor Recreation Economy in 11 Western States” (2017): <https://www.americanprogress.org/issues/green/reports/2017/09/27/439530/outdoor-recreation-big-business/>

Outdoor Industry Association, “Outdoor Participation Report 2017” (2017), available at [https://outdoorindustry.org/wp-content/uploads/2017/05/2017-Outdoor-Recreation-Participation-Report\\_FINAL.pdf](https://outdoorindustry.org/wp-content/uploads/2017/05/2017-Outdoor-Recreation-Participation-Report_FINAL.pdf).

<sup>40</sup>Outdoor Industry Association, “Outdoor Participation Report 2017” (2017), available at [https://outdoorindustry.org/wp-content/uploads/2017/05/2017-Outdoor-Recreation-Participation-Report\\_FINAL.pdf](https://outdoorindustry.org/wp-content/uploads/2017/05/2017-Outdoor-Recreation-Participation-Report_FINAL.pdf).

<sup>41</sup> Earth Economics, “Economic Analysis of Outdoor Recreation in Washington State” (2015), available at <http://www.rco.wa.gov/documents/ORTF/EconomicAnalysisOutdoorRec.pdf>.

average annual employment of a little under 20,000 workers with average earnings of \$46,314 (refer to **Table 32: Outdoor Recreation Sub-industry Breakout**).

**Table 32: Outdoor Recreation Sub-industry Breakout**

*Washington State, 2016 Annual Averages*

6 digit NAICS	Industry description	Average annual employment	Avg. Firms	Average annual wage	Total 2016 wages paid
336612	Boat building	2,471	81	\$47,809	\$118,137,048
339920	Sporting goods manufacturing	2,130	74	\$54,901	\$116,938,149
441210	Recreational vehicle dealers	1,946	92	\$53,264	\$103,652,604
441222	Boat dealers	1,055	138	\$44,136	\$46,563,351
483000	Water transportation	3,694	64	\$80,461	\$297,223,718
561520	Tour operators	667	69	\$56,356	\$37,589,744
611620	Sports and recreation instruction	3,798	456	\$15,398	\$58,480,350
712190	Nature parks and similar institutions	103	14	\$33,351	\$3,435,107
712130	Zoos and botanical gardens	558	30	\$43,178	\$24,093,058
488310	Port and harbor operations	294	18	\$58,780	\$17,281,397
487000	Scenic and sightseeing transportation	802	77	\$42,295	\$33,920,879
713920	Skiing facilities	*	*	*	*
721211	Rv parks and campgrounds	974	164	\$18,675	\$18,189,809
721214	Recreational and vacation camps	753	48	\$20,999	\$15,812,432
	<b>All Outdoor Recreation</b>	<b>19,245</b>	<b>1,325</b>	<b>\$46,314</b>	<b>\$891,317,646</b>

*Source: Washington State Employment Security Department, QCEW Annual Averages*

*\*Cannot publish due to confidentiality restrictions.*

The industry's average wage (\$46,314) recorded in 2016, compares unfavorably with the overall state average of \$58,928. But there are factors to consider: many of the industries include occupations such as recreation instructors and those that work at campgrounds, jobs that typically pay low wages to temporary workers. These are not the types of occupations intended by the report and the legislation that inspired it. In addition, it is difficult to determine where these jobs are located and the degree to which they involve actually working outdoors.

## Employer Interviews: Outdoor Recreation Sector Trends

The four employers interviewed stressed that computer technology is impacting outdoor recreation businesses – and their need for skilled, mid-level employees – in myriad ways. Two of the employers manufacture outdoor recreation products, while the other two provide recreation services, but all see technology as central to their operations. Some companies are employing computers to engage and capitalize on a growing customer base through the expansion of online sales of fishing equipment; others must meet the market demands driving efficiency through the automation of heavy equipment, such as to groom or remove snow during ski season. Other companies are looking into robotics to streamline manufacturing processes. One recreation boat manufacturing manager noted this impact in relation to fabricating boat hulls: “More and more components and processes are being digitally controlled. Some businesses are already programming computers to run rigging stuff (installing electronic systems in watercraft) and it is continuing to broaden. There is a real opportunity for automation to affect a lot of different areas, but welding is the most applicable.”

“More and more components and processes are being digitally controlled...This is a real opportunity for automation to affect a lot of different areas.”

Expanding the use of lean manufacturing tools and methods to boost efficiency and productivity is also a common goal in this sector, reflecting both an opportunity to increase profits and a competitiveness challenge in a global economy. One manager at an outdoor recreation equipment manufacturing company stated: “The biggest trend in the industry is a focus on lean manufacturing – especially as we try to move jobs from China back into the states. In China, they are agile in making their own machines and lean processes in-house, and that’s a great advantage. We can’t just buy the machines we need off the shelf – we need to design and fabricate them ourselves.”

As technology and lean methods apply to the workforce, employers emphasized their concern about the challenges of finding qualified applicants to fill existing skill gaps and replace retiring workers. One HR manager noted the labor “squeeze” that is felt by many employers who rely on a technical mid-level labor force: “We have an aging workforce with no skilled or trained young people coming up into these paths.” The same manager added: “Up until about now, you could be a lift (ski lift) mechanic and not really need to use a computer. Now, we’re moving to electronic documents and storage of maintenance records.” This means that young people looking to enter these industries need to have both an aptitude for mechanical or electrical systems and an aptitude for understanding how modern computer systems are increasingly integrated into an employer’s operations. Some employers tied the lack of mid-level applicants to insufficient preparation for skilled, mid-level jobs by the state’s public school system. One recreation equipment manufacturing manager reported that young people are not pursuing these pathways, in part, because “Our schools aren’t doing a great job of growing skills for these types of jobs and pointing students in this direction. Washington needs to start to home grow its workforce by doing a better job pointing capable, interested students into companies like us. The trend is we’re not home growing anything, really.”

“Washington needs to start to home grow its workforce by doing a better job pointing capable, interested students into companies like us.”

## Employment, Occupations and Requirements

The four outdoor recreation-sector employers who participated (Summit at Snoqualmie, Cascade Designs, Red's Fly Shop and Renaissance Marine) provided information on the full range of mid-level, technically oriented occupations, following the criteria provided by the research team that defined mid-level occupations used in this study.<sup>42</sup> These employers identified a total of 47 different job titles that met the definition at the sites they were reporting. Total employment (headcount) in all skilled mid-level occupations was 183 (refer to **Appendix 2** for the full list of occupations and employment-related data collected from employers).<sup>43</sup>

## High-Priority Occupations

Employers were also asked to identify up to three (3) of occupations they regarded as a high priority for employment. High-priority jobs were generally defined as occupations that are currently hard to fill due to lack of qualified applicants, skill gaps among existing employees, or because of anticipated future hiring or retirements (refer to **Table 33: High Priority Jobs in Outdoor Recreation**). Some of these job titles are generic ("maintenance mechanic") while others are uniquely named and specific to individual employers, but may represent many of the functions or duties of job titles that are named something different by other employers.<sup>44</sup>

## High-Priority Outdoor Recreation Jobs, Employment and Projections

Table 29 shows that many of the 11 occupations identified by employers relate to a very diverse range of work functions and roles: manufacturing processes, mechanical and electrical maintenance, followed by management, and service-related jobs. Jig welders were the largest single group, with several current job vacancies, and this occupation is anticipated to have considerable new hiring over the next three years. New hiring for fly shop associates reflects anticipated expansion and growth in retail business volume over time.

Primary reasons given by employers for identifying these high-priority jobs include that qualified applicants are difficult to find, and that the specialized skills required are central to ensuring ongoing manufacturing operations, and maintaining equipment and productivity. For management and service jobs, detailed technical knowledge of the industry gained through experience was cited as critical to serving customers and their needs; these are high "personal touch" jobs that involve direct interactions with customers regarding products, services and guided outdoor experiences. And, while the numbers for some jobs are relatively small, these positions were regarded as essential to business success. Indeed, in smaller companies with fewer employees, the lack of qualified skilled workers can be especially challenging because they may rely on a single employee to perform several critical jobs (refer to **Table 33: High Priority Jobs in the Outdoor Recreation**).

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<sup>42</sup> For this study, employers were asked to report technically oriented jobs that are directly tied to the primary product or services that are created and marketed by the organization, and for which the equivalent of a high school diploma (minimum) but less than a four-year college degree is generally a requirement for those jobs.

<sup>43</sup> As noted earlier, these numerical data are limited to the occupations identified by participating employers, and are primarily provided for identification and illustration. These data cannot be generalized to represent the industry as a whole.

<sup>44</sup> Because the project included large and small employers, and not all employers use the same job titles for similar jobs, the number of some common job titles may vary considerably compared to others.

**Table 33: High Priority Jobs in Outdoor Recreation**

Job Title	Employment	Job Vacancies	New Hiring, Next 3 Years	Retirements, Next 3 Years
Jig Welder	37	6	20	4
Rigger	13	3	5	1
Lift Maintenance Mechanic	11	0	0	2
Fishing Guide	10	0	0	0
Paint Prep Technician	8	1	4	0
Maintenance Mechanic	6	2	2	0
Fly Shop Associate	5	0	10	0
Vehicle Maintenance Mechanic	5	1	0	1
Electrician	3	0	0	0
Manufacturing Engineer	2	0	0	0
Fly Shop Manager	1	0	0	1
<b>TOTAL</b>	<b>101</b>	<b>13</b>	<b>41</b>	<b>9</b>

*Source: Employer interviews conducted by Washington State University*

### Contracted Employment

Some employers rely on contracted employment to support work functions or tasks characteristic of skilled mid-level occupations. Because contracted employment is provided by external companies or individual contractors, they are not reported above. Overall, the four outdoor recreation employers interviewed do not rely on contract hiring to perform regular mid-level technical work. The one exception was that one employer regularly hires up to 10 contract fishing guides to increase capacity during high-season(s). More often, these employers occasionally contract for specialized expertise or technical skills, such as certain welding methods and production jobs, or for specific construction projects.

### Outdoor Recreation: Knowledge, Skills, Abilities and Pathways

The following sections highlight data collected directly from participating employers about the primary knowledge, skills and abilities they regarded as important qualities for each of the high-priority occupations they identified. Interview topics included technical skills, other important knowledge, skills and abilities, formal preparation, typical entry pathways, and next-level employment (advancement).

**Technical Skills:** Employers were asked to describe the leading core technical skills and specific technical skills they saw as especially important to have in these high-priority jobs. The technically related knowledge, skills and abilities reported below are not meant to represent comprehensive job descriptions or requirements, but rather reflect the general topics and skill sets that these employers viewed as essential competencies for these positions.<sup>15</sup>

Employers place considerable emphasis on specialized knowledge and skills required to perform work requirements in each specific occupation, and there is great emphasis on physical and technical fundamentals as well as applied knowledge of technology and computer applications (refer to **Table 34: Core and Specific Technical Skills by Job Title in**

Outdoor Recreation). While this is evident in all trade and manufacturing-related job types, the need for foundational knowledge of the industry – including techniques, equipment, financial and online systems, as well as personal experience – is also evident in management and customer-facing occupations. For most technical jobs, the ability to read and understand blueprints, schematics and manuals is a common requirement.

**Table 34: Core and Specific Technical Skills by Job Title in Outdoor Recreation**

<b>Job Title</b>	<b>Core Technical Skills</b>	<b>Specific Technical Skills</b>
Jig Welder	<ul style="list-style-type: none"> <li>• Knowledge of and ability to use an aluminum welding machine</li> <li>• Conversant in reading plans, drawings, and blueprints and be able to apply this information</li> </ul>	<ul style="list-style-type: none"> <li>• Proficiency with an aluminum welding machine</li> </ul>
Rigger	<ul style="list-style-type: none"> <li>• Generalist mechanical abilities similar to those required for auto repair or motorized or electronic controls installation</li> <li>• Conversant in reading plans, drawings, and blueprints and be able to apply this information</li> </ul>	<ul style="list-style-type: none"> <li>• Use of ordinary and specialized hand and power tools to install operational and accessory systems and components</li> </ul>
Lift Maintenance Mechanic	<ul style="list-style-type: none"> <li>• Can rebuild gear boxes</li> <li>• Knowledge of how to use come-alongs, cranes, heavy equipment, rigging, hand and power tools,</li> </ul>	<ul style="list-style-type: none"> <li>• Mechanical knowledge of ski lift grips and wheels</li> <li>• Mechanical knowledge of alignment work on ski lift towers</li> </ul>
Fishing Guide	<ul style="list-style-type: none"> <li>• Knowledge of classic and new fly fishing methods and equipment</li> <li>• Knowledge of the fly fishing industry and trends</li> <li>• An understanding of the science around aquatics, how weather conditions impact fly fishing</li> <li>• Knowledge of safety and what to do in emergency situations</li> </ul>	<ul style="list-style-type: none"> <li>• Advanced knowledge of target waters, target species, applicable laws, rules, and regulations associated with fly fishing</li> </ul>
Paint Prep Technician	<ul style="list-style-type: none"> <li>• Knowledge of general aluminum sanding methods and cutting tools</li> </ul>	
Maintenance Mechanic	<ul style="list-style-type: none"> <li>• Knowledge of production operations, machinery, mechanical and electrical equipment</li> <li>• Knowledge to troubleshoot, install, repair and replace electro-mechanical equipment such as motors, pneumatic and hydraulic tools, conveyor systems, and production machines</li> <li>• Ability to interpret diagrams, sketches, operations manuals, manufacturer's instructions, and engineering specifications</li> </ul>	
Fly Shop Associate	<ul style="list-style-type: none"> <li>• Knowledge of fishing and related sciences, weather, stream flow dynamics, and safety</li> <li>• Basic cashiering</li> <li>• Can calculate discounts</li> <li>• Knowledge of inventory and online sales systems</li> </ul>	<ul style="list-style-type: none"> <li>• Technical knowledge of fishing industry, techniques</li> <li>• Water safety, and related sciences, including weather, obstructions and stream flow dynamics</li> </ul>
Vehicle	<ul style="list-style-type: none"> <li>• Maintenance of welders, chainsaws, pumps,</li> </ul>	<ul style="list-style-type: none"> <li>• Mechanical knowledge for maintenance</li> </ul>

Maintenance Mech.	<ul style="list-style-type: none"> <li>and other small engine-type equipment</li> <li>• Troubleshooting, preventative maintenance, and vehicle inspections on pick-up trucks, shuttle buses</li> </ul>	<ul style="list-style-type: none"> <li>of snow blowers, graders, loaders, excavators, and dump trucks</li> <li>• Mechanical knowledge of diesel engines</li> </ul>
Electrician	<ul style="list-style-type: none"> <li>• Can run conduit and pull wire</li> <li>• Install light poles</li> <li>• Can use infrared camera to inspect for good fittings inside electrical boxes</li> <li>• Basic knowledge of electrical systems</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge of low voltage electrical related to ski lift operations</li> <li>• Knowledge of electrical components related to electric drives (but also drum and speed controllers) for ski lift</li> </ul>
Manufacturing Engineer	<ul style="list-style-type: none"> <li>• Ability to read and comprehend basic engineering drawings and schematics</li> <li>• Understanding of pneumatics</li> <li>• Understanding of machine transmissions and motor transitions</li> </ul>	<ul style="list-style-type: none"> <li>• 3D CAD experience</li> <li>• SolidWorks software</li> <li>• Basic material flow or line setup for smooth/efficient manufacturing operations</li> <li>• Basic knowledge of load and stress as it relates to different materials</li> </ul>
Fly Shop Manager	<ul style="list-style-type: none"> <li>• Computer skills reflecting strong proficiency with windows-based program and progressive understanding of internet systems and cloud-based storage</li> <li>• Understanding of financial basics, operational systems, procedures, stocking inventory, ordering, and follow-up</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge of all fly-fishing gear, methods, and techniques</li> <li>• Knowledge of rafting equipment</li> <li>• Personal experience with fly fishing</li> </ul>

**Source: Employer interviews conducted by Washington State University**

**Outdoor Recreation: Other Knowledge, Skills and Abilities:** The physical nature of most of these jobs, and the weather and work conditions under which work tasks are performed, underscores the need to be physically fit, coordinated, adaptable, and with good safety awareness. While this was especially true for technical job types, these skill sets cut across all employers. The ability to communicate well in all forms and to work as part of a team was also stressed, as was the need for cross-training in multiple areas, to get along well with others (customers and co-workers), and also demonstrate a good work ethic. Enthusiasm and customer service skills were emphasized for customer-facing jobs (refer to **Table 35: Other Knowledge, Skills and Abilities by Job Title in Outdoor Recreation**).

**Table 35: Other Knowledge, Skills and Abilities by Job Title in Outdoor Recreation**

Job Title	Other KSAs
Jig Welder	<ul style="list-style-type: none"> <li>• Good work ethic and attitude</li> <li>• Can get along well with others</li> <li>• Can work in teams</li> <li>• Awareness of how one’s actions affect others</li> </ul>
Rigger	<ul style="list-style-type: none"> <li>• Good work ethic and attitude</li> <li>• Can get along well with others</li> <li>• Can work in teams</li> <li>• Awareness of how one’s actions affect others</li> </ul>
Lift Maintenance Mechanic	<ul style="list-style-type: none"> <li>• Genuinely welcomes guests: smiles, makes eye contact, engages guests in conversation, and thanks them for their patronage</li> <li>• Accurate, attention to detail</li> <li>• Can work in teams – upbeat and dependable, can cooperate</li> <li>• Good communication skills</li> <li>• Safety minded</li> <li>• Willing to cross train</li> </ul>
Fishing Guide	<ul style="list-style-type: none"> <li>• Enthusiastic</li> <li>• Can build relationships</li> <li>• Confident</li> <li>• Hospitality skills</li> <li>• Written and verbal communication skills</li> <li>• Can work in teams</li> </ul>
Paint Prep Technician	<ul style="list-style-type: none"> <li>• Good work ethic and attitude</li> <li>• Can get along well with others</li> <li>• Can work in teams</li> <li>• Awareness of how one’s actions affect others</li> <li>• Creative – dedicated to highest quality possible</li> </ul>
Maintenance Mechanic	<ul style="list-style-type: none"> <li>• Problem solving</li> <li>• Teamwork</li> <li>• Good work ethic</li> <li>• Communications skills</li> </ul>
Fly Shop Associate	<ul style="list-style-type: none"> <li>• Enthusiastic</li> <li>• Can build relationships</li> <li>• Confident</li> <li>• Hospitality skills</li> <li>• Written and verbal communication skills</li> <li>• Can work in teams</li> </ul>
Vehicle Maintenance Mech.	<ul style="list-style-type: none"> <li>• Takes initiative to get any and all jobs completed accurately and proficiently, and is someone who doesn’t understand the term “not my job”</li> <li>• Genuinely welcomes guests: smiles, makes eye contact, engages guests in conversation, and thanks them for their patronage</li> <li>• Accurate, attention to detail</li> <li>• Can work in teams – upbeat and dependable, can cooperate</li> <li>• Good communication skills</li> <li>• Safety minded</li> <li>• Willing to cross train</li> </ul>
Electrician	<ul style="list-style-type: none"> <li>• Genuinely welcomes guests: smiles, makes eye contact, engages guests in conversation, and thanks them for their patronage</li> <li>• Accurate, attention to detail</li> <li>• Can work in teams – upbeat and dependable, can cooperate</li> <li>• Good communication skills</li> </ul>

	<ul style="list-style-type: none"> <li>• Safety minded</li> <li>• Willing to cross train</li> <li>• Can work under minimal supervision</li> <li>• Flexible working hours</li> </ul>
Manufacturing Engineer	<ul style="list-style-type: none"> <li>• Knowledge of supervisory principles and practices</li> <li>• Knowledge of existing traffic laws, ordinances and rules</li> <li>• Knowledge of occupational hazards and standard safety practices associated with the use of heavy equipment and machinery</li> <li>• Can organize and prioritize work assignments and projects</li> <li>• Ability to supervise and motivate crew members</li> <li>• Ability to manage and implement multiple projects over large areas of land</li> <li>• Ability to perform a variety of manual tasks for extended periods in various weather conditions</li> <li>• Ability to prepare written reports and forms</li> <li>• Can work independently</li> <li>• Verbal and written communication skills (communicates with a wide array of individuals - biologists, tribal members, business interactions, other crews, cultural specialists, the public)</li> <li>• Calm demeanor</li> </ul>
Fly Shop Manager	<ul style="list-style-type: none"> <li>• Managerial organization, documentation and timely completion of objectives, time management and organization</li> <li>• Ability to stay on task during busy season as well as not losing momentum during the slow season</li> <li>• Written and verbal communication skills</li> <li>• Quickly and effectively document and communicate internally</li> <li>• Can work in teams</li> <li>• Understanding of one's position as part of a larger system</li> </ul>

**Source: Employer interviews conducted by Washington State University**

**Outdoor Recreation: Formal Preparation:** All employers prefer or require a high school or equivalent degree for employment, and nearly all reported that they have additional occupation-specific requirements for entry into most positions. Some of these occupations are entry-level and require little or no experience, while others such as Manufacturing Engineer, is an advanced-level occupation that demands extensive experience and/or education and training for entry. In some cases, specialized certifications or tests related to the job are expected for employment, or they are desired and provide a competitive advantage for applicants (refer to **Table 36: Required Formal Preparation in Outdoor Recreation**).

**Table 36: Required Formal Preparation in Outdoor Recreation**

Job Title	Required Formal Preparation
Jig Welder	<ul style="list-style-type: none"> <li>• No formal education is required, though a high school degree is preferred over a GED</li> <li>• While not required, 2 years of aluminum welding experience would prepare anyone with required skills</li> <li>• Company puts applicants through a basic welding test</li> </ul>
Rigger	<ul style="list-style-type: none"> <li>• No formal education is required, though a high school degree is preferred over a GED</li> <li>• While there is no required work experience, having some employed experience working in a mechanical setting is beneficial</li> </ul>
Lift Maintenance Mechanic	<ul style="list-style-type: none"> <li>• High school completion</li> <li>• Prefer some formal education, training in mechanics</li> </ul>

Fishing Guide	<ul style="list-style-type: none"> <li>• High school degree is preferred, and any customer services, business-related, or outdoor recreation certifications or degrees is a bonus</li> <li>• Customer service experience</li> <li>• Many new guides get trained for the first-time post hire</li> </ul>
Paint Prep Technician	<ul style="list-style-type: none"> <li>• No formal education is required, though a high school degree is preferred over a GED</li> <li>• No prior work experience is required</li> </ul>
Maintenance Mechanic	<ul style="list-style-type: none"> <li>• No formal education is required, though a high school degree is preferred over a GED</li> <li>• While not required, 2 years of mechanical and maintenance experience is desirable</li> </ul>
Fly Shop Associate	<ul style="list-style-type: none"> <li>• High school degree is preferred, though any customer services, business-related, or outdoor recreation certifications or degrees is a bonus</li> <li>• Need to have experience (work or hobby) that provides in-depth fishing/guide knowledge; details like what's hot, which rivers to fish and technical details like equipment and fishing methods</li> </ul>
Vehicle Maintenance Mechanic	<ul style="list-style-type: none"> <li>• No minimum education required</li> <li>• A minimum of 1 year of experience in automotive and/or trade school for automotive</li> <li>• Experience welding oxy-acetylene and fabrication is a plus</li> <li>• Valid driver's license</li> </ul>
Electrician	<ul style="list-style-type: none"> <li>• No minimum education required</li> <li>• One to two years' experience in electrical work</li> </ul>
Manufacturing Engineer	<ul style="list-style-type: none"> <li>• Six years' experience in the field, though a 4-year technical degree would be helpful</li> </ul>
Fly Shop Manager	<ul style="list-style-type: none"> <li>• High school degree is preferred, though any customer services, business-related, or outdoor recreation certifications or degrees is a bonus</li> <li>• Having an AA degree in business or economics would be beneficial, though solid prior work experience would also be acceptable</li> <li>• Having work experience offering financial experience, running reports, budgets, and inventory is beneficial</li> </ul>

**Source: Employer interviews conducted by Washington State University**

**Outdoor Recreation: Typical Entry Pathways:** Experience-based knowledge and interest in the specific outdoor recreation domain represented by the company appears to be the first-order expectation by most employers, and this expectation is pervasive across most high-priority jobs. Those that require higher levels of technical knowledge and experience, such as Manufacturing Engineer, are clearly more focused on individuals with proven specialized technology skills and competencies, whether acquired internally or through other technical employment. It is worth noting that all but one of these employers rely on ongoing mechanical systems to manufacture or deliver core products or services (manufacturing, ski lifts), which emphasizes a central role for technical and maintenance knowledge and skill in their organizations (refer to **Table 37: Typical Occupational Pathways in Outdoor Recreation**).

**Table 37: Typical Occupational Pathways in Outdoor Recreation**

Job Title	Typical Pathways
Jig Welder	Success in this job reflects exposure and competency as an aluminum welder over formal training. Reflecting this, most employees come into this position after having worked for about 2 years as an aluminum welder for another business. The company has a generalist aluminum welding test they put all qualified candidates through.
Rigger	Entry into this job is more about exposure, which can come from a variety of sources (i.e., interest, desire, hobby, or prior experience in mechanical work). Past employees have come out of irrigation, auto repair, or even high school shop class.
Lift Maintenance Mechanic	Individuals who end up in this position have a love for the outdoors – being immersed in nature. It would be common for an individual to come into this position following several years of summer work (brush cutting, ditch digging, paint crew). Ability to get to know and get along with others at the organization is key.
Fishing Guide	Qualified applicants often start with the company as a contract (or temporary) guide. A high school degree is preferred along with experience in customer service and experience/interest in outdoor recreation. It is often the case that these individuals could be college students working summer jobs or retirees with fly fishing experience/skills who have a desire to advance themselves in the industry.
Paint Prep Technician	This is an entry level position, so qualified applicants typically come straight out of high school and have the drive to work.
Maintenance Mechanic	Entry into this job is more about exposure, which can come from a variety of sources, including prior experience in mechanical work, training and related employment.
Fly Shop Associate	This is an entry-level position. A high school degree is preferred along with experience in customer service and experience/interest in outdoor recreation and specific understanding and knowledge of fishing basics, equipment and techniques, and related knowledge.
Vehicle Maintenance Mechanic	The most typical pathway is first for someone to have an interest in the ski industry. After gaining some experience working in other mechanic-related jobs, preferably diesel mechanics, one would have the skills required to do the job.
Electrician	The most typical pathway is for someone to have an interest in the ski industry. All current electricians came into the position from somewhere else within the company – that expertise and the ability to get to know and get along with others at the organization is key.
Manufacturing Engineer	Often, individuals start out as a manufacturing or mechanical engineer technician, maintenance technician, or engineering technician and are promoted from within. Alternatively, they could come from another company that has similar requirements. Individuals who have completed a 2-year tech/vocational school are looked at seriously.
Fly Shop Manager	A high school degree is preferred along with solid experience/interest in outdoor recreation activities. Qualified individuals have experience in customer services and have proven experience and leadership in a fly shop/guide shop management setting.

**Source:** Employer interviews conducted by Washington State University

**Outdoor Recreation: Next-Level Employment:** All employers reported that there are pathways for advancement into other functions or positions. With successive advancement in some occupations, candidates can pursue opportunities at higher levels of technical work based on experience or additional education and training. Lateral advancement into other departments or job functions, such as management, is also possible with experience. In some cases, especially in smaller companies, the number of next-level positions is limited, and advancement opportunities are more available outside of technical positions, or are found by pursuing employment opportunities at other companies or industries (refer to **Table 38: Next-Level Employment Opportunities in Outdoor Recreation Careers**)

**Table 38: Next-Level Employment Opportunities in Outdoor Recreation Careers**

Job Title	Next-Level Employment Opportunities
Jig Welder	This is a progressive position. There are three different levels of welding assembly, with each requiring different welding skills and abilities that individuals typically advance through. The first station is rough configuration. Here, the basic shape of the boat is established. This is where most generalist welders start. The second is where welding skill increases as the welders are closer to finishing welding. The third is where all finishing welding takes place. These are the welds that will be visible on the finished product, so they need to look good. This is also where the skill is the highest – requires the most artistic/creative and experienced welders.
Rigger	This is a progressive position. There are different stages of finishing that require different sets of knowledge and abilities. Some tasks are more general while some are more specific. As riggers become more experienced, their knowledge set typically moves into more “brand specific” installation of motors, radios, and/or horns.
Lift Maintenance Mechanic	There is little room for upward mobility, however, individuals could move in to the outside operations manager position with enough experience at the company.
Fishing Guide	For those who come in as a temporary guide, there is opportunity to move into a permanent guide position, fly shop associate, or fly shop manager.
Paint Prep Technician	If an individual wants to stay in the paint department, they can move from a paint prep technician position to a painter within 12-18 months, though there is opportunity to move anywhere within the business from this position.
Maintenance Mechanic	This is a progressive position with opportunities for more specialized technical work, new projects, or supervision.
Shop Associate	Can move into a permanent fishing guide, floor manager, or fly shop manager.
Vehicle Maintenance Mechanic	There is little room for upward mobility, however, individuals could move in to the outside operations manager position with enough experience at the company.
Electrician	There is little room for upward mobility, however, individuals could move in to the outside operations manager position with enough experience at the company.
Manufacturing Engineer	The position is progressive through four levels, though levels three and four usually would require a four-year degree. Those in level one could move to product design, product development, or machine engineering.
Fly Shop Manager	This position is the highest level below the business owners, so advancement would typically be outward (i.e., start own business or join a different/larger business).

**Source: Employer interviews conducted by Washington State University**

## State-Level Age Demographic Trends

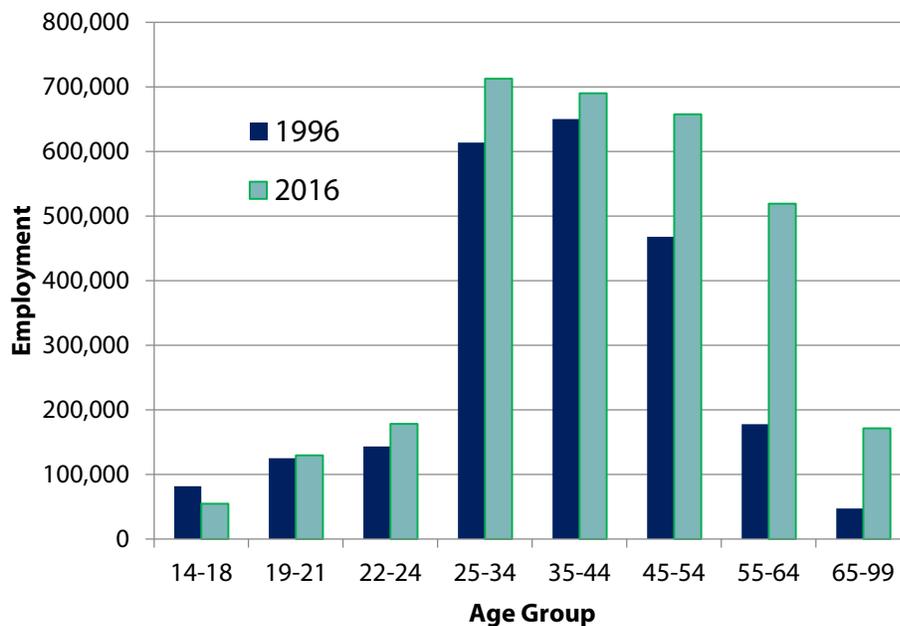
Workers with highly technical and in-demand skills, such as welding or machining, are rapidly aging. This is a significant risk for businesses that are unable to attract or find younger workers that are suitably skilled. Although the occupational demand for some of the roles held by older workers may be stagnant or in decline, there are still some job openings.

An aging workforce is expected to cause an increase in demand for new workers due to retirements. This is true for the economy as a whole, but could be an especially important issue with skilled mid-level, rural STEM workers. The state workforce itself is generally growing older, and any comparison should be made against this widespread trend. This poses an opportunity for young people, contingent upon sufficient levels of awareness of future openings, and their ability to access necessary training (refer to **Chart 4: Changing Age Patterns in Washington Workers**).

This pattern doesn't vary dramatically between urban and rural areas, except there are slightly more 55+ workers, and slightly fewer young adult workers, outside of the Western-urban area. This difference is insignificant compared to the demographic shift over time.

### Chart 4: Changing Age Patterns in Washington Workers

Washington State, 2006 & 2016



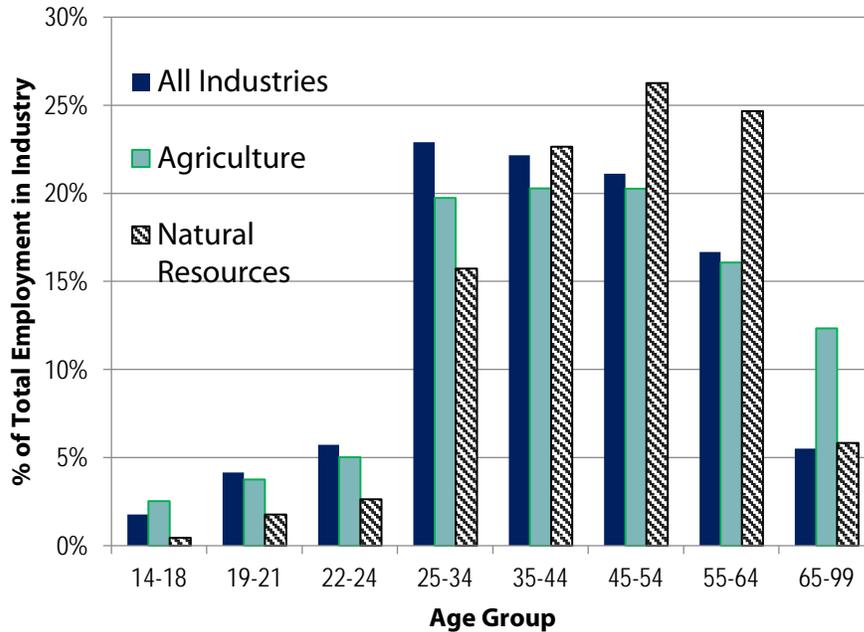
Source: U.S. Census Bureau, LEHD

There is also a small difference in the educational attainment by age, at least when looking only at currently employed workers. About 32 percent of the 25-34 year-old workers hold a mid-level (more than high school, but less than bachelor's degree) education, where 36 percent of 55-64 year-old workers do. The differences in age patterns are more pronounced by industry. Comparisons across industries can be made by looking at the share of each age

group compared to the total for that industry. Comparing the industries profiled above to the economy as a whole shows that agriculture has a high level of 65+ year-old workers, and natural resources has a high level of 45-64 year-old workers (refer to **Chart 5: Age Distributions in Selected Industries**).

### Chart 5: Age Distributions in Selected Industries

Washington State, 2016



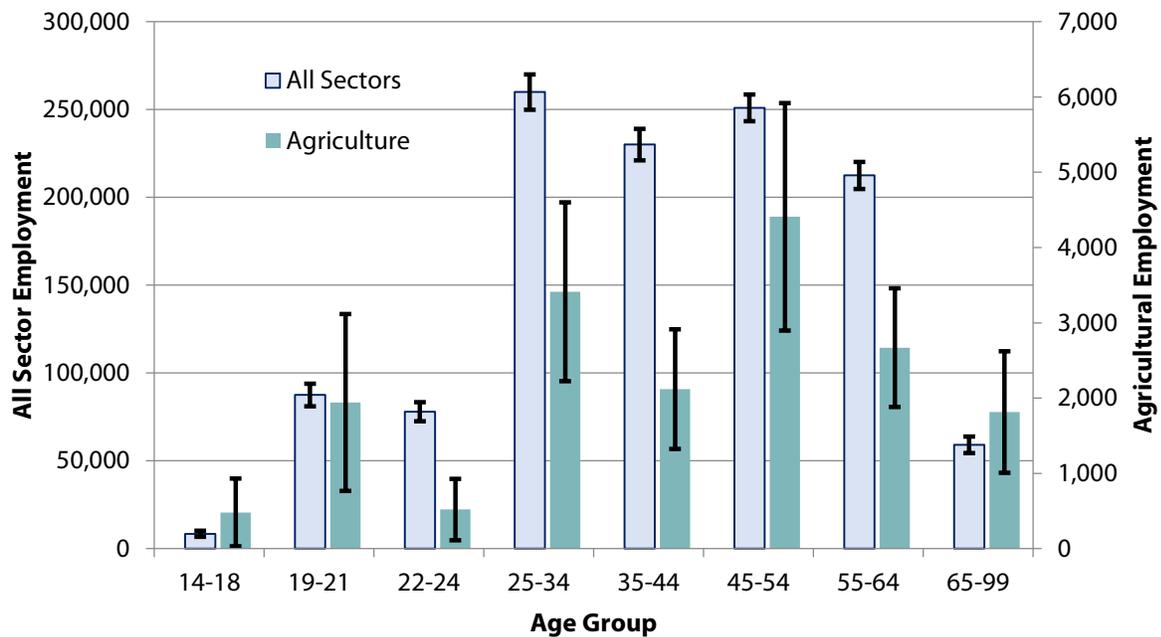
Source: U.S. Census Bureau, LEHD

### Margin of Error Limits Sector Detail

Publically available data generally contains a cross-section of the economy by area and one other measure, such as occupation or industry. For example, the Census Longitudinal Employer-Household Dynamics (LEHD) program combines some demographic data and industry data, but does not contain occupation. In contrast, the American Community Survey (ACS) contains many measures at an individual level. The Public Use Microdata Sample (PUMS), in particular, can be tabulated to explore very specific parts of the economy. However, it was designed to measure the population as a whole, and despite its large national sample size of 3.5 million households, can quickly become meaningless in small sectors. Questions relevant to this assessment mostly return noise once the results are lower than tens of thousands of workers per result, meaning there is not enough resolution to draw any conclusions for more narrowly defined sectors (refer to **Chart 6: Age Patterns by Industry for Workers with Mid-level Education**).

## Chart 6: Age Patterns by Industry for Workers with Mid-Level Education

Washington State, 2016, 90 percent confidence error bounds



Source: U.S. Census Bureau, ACS PUMS

\*Note: estimates are not exact. The terminal ends on the 'whisker' bars indicate a sampling error of plus or minus within 90 percent of where the true age range exists in the population.

## Job-Postings and Skill Clusters Demand

The Burning Glass database can be used at a high level to aggregate numerous job-postings for any number of combinations of occupations and industry sectors, which can be broken down into regional areas, such as counties or metropolitan statistical areas. One of the major limitations of this data resource is that online job postings are not necessarily reflective of actual occupational demand. For whatever reason, an employer may not, for instance, post every job opening online. Moreover, the required skills listed in an occupation may not be representative of what skills constitute an occupation, but rather, is an employer's preference for a selection of skills within an occupation. Or, a shared basket of skills could overlap different occupations. For example, millwrights share many skill sets with other occupations such as electricians or welders. The issue here is that demand projections may not be accurate if based on job title or occupation code alone. It could be that the skills that constitute an occupation, such as millwrights, may be higher than the occupation itself, especially if such skills are highly transferable across other industries and occupations (refer to **Appendix 3** for a full summary of online job posting data aggregated by Burning Glass for High Priority Jobs Identified by Interviewed Employers).

## Millwrights Case Study

Occupations are arguably becoming more cross-functional. Many businesses are compelled to operate on a cost-leadership model in an increasingly competitive global market. This puts added pressure on companies to do more with fewer people, often supplemented with automation. Traditional occupations like millwrights and mechanics are being transformed, bringing into question the relevancy of their job titles. As a case-in-point, these positions require skills that are equally suited for other job titles, like repairmen, electricians, or production technicians. They may also be required to take on scheduling tasks, budgeting, and other supervisory roles (or supervise themselves), which requires the use of word processors, emails, and spreadsheets – skills not typically associated with someone who holding the title of ‘mechanic’.

This bears certain policy implications when it comes to workforce development. For example, data used to project occupational demand might be missing the point when there is a mismatch in occupational coding versus what skills employers are actually requiring. This mismatch could become more pronounced as the nature of work – and the associated skills required to do a job continue to change. A more holistic approach may be needed to bring context to the data; context that will require more seats at the table when it comes to bridging skills gaps between workers and in-demand jobs.

One of the issues that arose through discussions with employers of skilled technical workers, is that there is a disassociation between conventional supply-demand gap studies and their experiences for some occupations. This case study, which highlights the millwright occupation, explores some of the underlying causes of this issue, with potential application to other occupations experiencing similar disassociations.

In recent years millwrights have generally not been considered in-demand occupations. The Washington State Employment Security Department (ESD) in coordination with local Workforce Development Councils maintains a list of in-demand occupations. For instance, the list indicates that millwrights are only in demand for three sub-regions in the state (refer to **Table 39: Demand Status of Millwrights by Workforce Region, 2018**).

**Table 39: Demand Status of Millwrights by Workforce Region, 2018<sup>45</sup>**

Status	Area name	Last update
Not in demand	Washington State	7/23/2018
Not in demand	Eastern Washington WDA: Asotin, Whitman, Garfield Counties	7/23/2018
Not in demand	Eastern Washington WDA: Columbia, Walla Walla Counties	7/23/2018
Not in demand	Eastern Washington WDA: Stevens, Ferry, Pend Oreille, Lincoln counties	7/23/2018
Not in demand	North Central WDA: Chelan/Douglas counties	7/23/2018
Not in demand	North Central WDA: Grant, Adams counties	7/23/2018
Not in demand	North Central WDA: Okanogan County	7/23/2018
<b>In demand</b>	<b>Northwest WDA: Island, San Juan counties</b>	<b>7/23/2018</b>
<b>In demand</b>	<b>Northwest WDA: Skagit county</b>	<b>7/23/2018</b>
<b>In demand</b>	<b>Northwest WDA: Whatcom county</b>	<b>7/23/2018</b>
Not in demand	Pacific Mountain WDA: Grays Harbor, Lewis, Mason, Pacific, Thurston counties	7/23/2018
Not in demand	Pierce WDA: Pierce County	7/23/2018
Not in demand	Seattle King WDA: King County	7/23/2018
Not in demand	Snohomish WDA: Snohomish County	7/23/2018
Not in demand	Southwest WDA: Clark County	7/23/2018
Not in demand	Southwest WDA: Cowlitz, Wahkiakum counties	7/23/2018
Not in demand	Spokane WDA: Spokane County	7/23/2018

**Source: Washington State Employment Security Department**

*\*Note that this demand is determined by the Employment Security Department using existing data. In many cases it conflicts with what we have heard from employers. For more explanation please read the Millwrights Case Study section.*

The demand status in **Table 39** is primarily derived from occupational growth rates and openings relative to other occupations in the same workforce region. The demand status is adjusted by ESD using supply/demand data derived from online job postings compared to unemployment insurance claims. If the supply/demand information significantly contradicts the projections data, adjustments are made<sup>46</sup>. Note that in the projections data, there is not a single period for any area where millwright growth rates match that of all occupations (refer

<sup>45</sup> \*Bold font indicate "In-demand"

<sup>46</sup> For more information on this process see their website:  
<https://esd.wa.gov/labormarketinfo/learn-about-an-occupation#/search>

to **Table 40: Occupational Projections by Workforce Region**). In other words, the projections outlook in every case for millwrights is below average, which goes a long way in explaining the “not-in-demand” status. Despite that, there are a fair amount of annual openings expected, especially in the Pacific Mountain, Northwest, Southwest, and Spokane regions.

**Table 40: Occupational Projections by Workforce Region**

*\* Data was suppressed due to confidentiality or one of the employment estimations is less than 10*

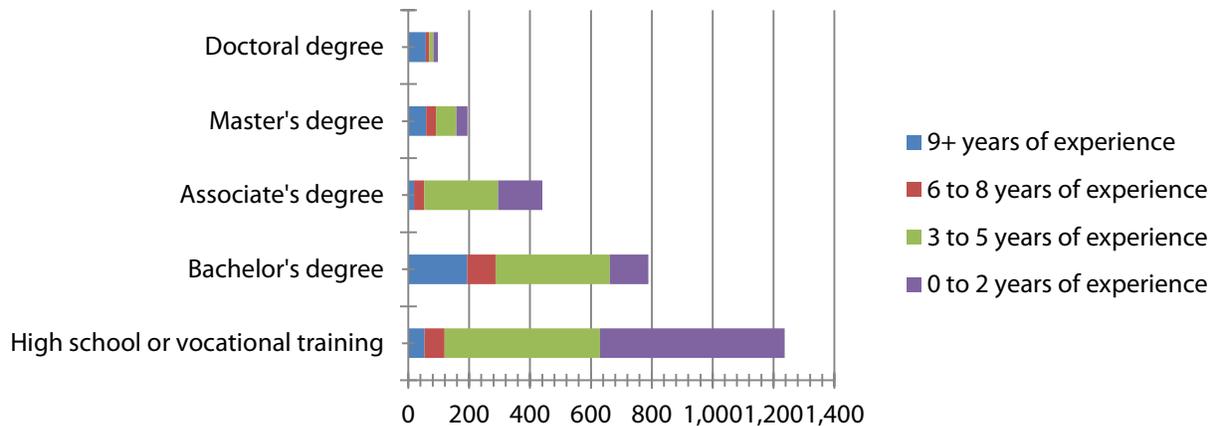
Workforce Development Name	Total, All Occupations				Millwrights			
	Employment 2019Q2	Avg. Ann. Growth 2016-2021	Avg. Ann. Growth 2021-2026	Avg. Ann. Openings 2016-2021	Employment 2019Q2	Avg. Ann. Growth 2016-2021	Avg. Ann. Growth 2021-2026	Avg. Ann. Openings 2016-2021
Washington State	3,940,423	2.02%	1.89%	1,333,912	1,471	0.25%	0.03%	397
Olympic	148,244	1.55%	1.55%	51,339	24	-1.59%	0.00%	7
Pacific Mountain	218,593	1.51%	1.52%	73,296	253	-0.77%	0.08%	66
Northwest	205,940	1.58%	1.56%	70,694	175	1.57%	-0.23%	47
Snohomish	340,768	1.46%	1.21%	111,382	74	0.00%	0.53%	20
Seattle-King	1,592,275	2.49%	2.40%	535,303	99	0.20%	-0.20%	26
Tacoma-Pierce	359,045	1.94%	1.73%	122,965	97	-0.61%	0.21%	25
Southwest	242,378	2.22%	2.12%	82,473	333	0.48%	0.06%	89
North Central	143,771	1.70%	1.33%	52,780	67	1.43%	0.27%	20
South Central	165,050	1.59%	1.34%	58,732	*	*	*	*
Eastern	93,348	1.45%	1.24%	30,753	66	-0.47%	-0.48%	32
Benton-Franklin	144,857	1.78%	1.57%	48,790	81	0.99%	0.71%	22
Spokane	263,861	1.65%	1.53%	88,432	173	0.47%	-0.47%	46

**Source: Washington State Employment Security Department**

One possible explanation for the discrepancy between what employers were seeing in the field and the end result of the existing supply-demand analysis is that employers are using different operational job titles, and so the data collection process muddies the end count. To examine this, the Workforce Board staff pulled data from Burning Glass for the purpose of comparing reported job titles against skill sets associated with the job to look for patterns.

### Chart 7: Required Millwright Education and Experience Levels in Job-Postings

Washington State, July 1, 2017 to June 30, 2018



Source: Burning Glass

In the 12-month time frame, from July 1, 2017 to June 30, 2018, Burning Glass reported a total of 113 unique posts asking for millwrights in Washington. This is somewhat less than the ESD-projected annual estimate for the same period, which reported 400 openings. Nearly 60 percent of the job postings on Burning Glass were found outside of the Central Puget Sound region, which does roughly correspond with the geographic distribution of openings in the ESD projections data. Over 90 percent of the Burning Glass postings were from manufacturing firms, including wood products manufacturing. In over three-quarters of these postings, where experience was a requirement, employers wanted someone with 3-5 years of experience. These discrepancies raise questions concerning potential skewedness around the propensity of online job postings relative to how experience may pertain to the occupational title an employer is using in the job posting.

**Table 41: Specific Skills Required for Millwrights in Washington***July 1, 2017 to June 30, 2018*

Skills	Job Postings
<b>Repair</b>	<b>76</b>
<b>Machinery</b>	<b>70</b>
<b>Hand Tools</b>	<b>63</b>
<b>Welding</b>	<b>53</b>
<b>Hoisting Equipment</b>	<b>38</b>
<b>Lathes</b>	<b>34</b>
<b>Blueprints</b>	<b>33</b>
<b>Schematic Diagrams</b>	<b>30</b>
Dollies	29
Forklift Operation	29
Power Tools	28
Scissor Lifts	25
Recruiting	24
Customer Service	22
Industrial Machinery Maintenance	20
Micrometers	16
Predictive / Preventative Maintenance	13
Calipers	12
Machining	11
Plumbing	10

**Source: *Burning Glass***

Comparisons of job-postings with similar requested skill sets as millwrights can be used to ascertain what other job titles might be being used in the *Burning Glass* data. For example “repair” was the most required job skill for millwrights, appearing in 76 posts over the period, followed by machinery and hand tools. Overall there were 20 skills cited (refer to **Table 41: Specific Skills Required for Millwrights in Washington**).

One way of testing whether employers were using different job titles, was to search for what postings required similar skill sets. For this the top eight skills for millwrights (refer to **Table 41** for skills in bold font), were searched for in the *Burning Glass* database (refer to **Table 42: Occupational Postings Requiring Top Eight Skills for Millwrights**).

**Table 42: Occupational Postings Requiring Top Eight for Millwrights Skills***Washington State, July 1, 2017 to June 30, 2018*

Occupation Postings Using "most or all" of the 8 Skills	Posts Requiring Most or All of these Skills
<b>Total</b>	<b>5,178</b>
Electricians (47-2111.00)	1,067
Welders, Cutters, and Welder Fitters (51-4121.06)	850
Bus and Truck Mechanics and Diesel Engine Specialists (49-3031.00)	724
Machinists (51-4041.00)	627
Industrial Machinery Mechanics (49-9041.00)	607
Rough Carpenters (47-2031.02)	538
Electrical and Electronic Equipment Assemblers (51-2022.00)	330
Mobile Heavy Equipment Mechanics, Except Engines (49-3042.00)	322
Millwrights (49-9044.00)	113

**Source: Burning Glass**

The most common occupational postings requiring similar skill sets to millwrights were electricians, welders, mechanics, and machinists. However, the list is based on occupations, not reported job titles. This gets back to the question of whether different employers might be using different working job titles for essentially the same or very similar jobs (refer to **Table 43: Job Title Postings Requiring Top Eight for Millwrights Skills**).

**Table 43: Job Title Postings Requiring Top Eight for Millwrights Skills***Washington State, July 1, 2017 to June 30, 2018*

Occupation Postings Using "most or all" of the Eight Skills	Posts Requiring Most or All of these Skills
Welder	639
Maintenance Technician	342
Mechanic	321
Maintenance Mechanic	291
Machinist	200
Merchandiser	193
Electrician	191
Electrical Engineer	130
CNC Machinist	107
Millwright	101
Building Engineer	100
Engineering Technician	94
Service Technician	91
Firmware Engineer	90

**Source: Burning Glass**

The welder occupation tops the list given that it had the most online postings, but one can probably assume that welder is commonly understood as a separate occupation from millwrights (despite some overlap in skills). Nonetheless, four of the top five on the list might have a large degree of overlap with millwrights, if not actually being the same occupation as a millwright by another name. These four job titles had over 1,100 postings, a considerable increase over the 113 postings for millwrights alone.

The challenge with using job posting aggregations as a means to measure demand is that it is unclear how exactly an employer defines an occupation by its title, and by extension, what skills they require to fill a role. Indeed, an employer may require a skill set more nuanced than is typically understood as the skill sets defined in an occupation implied by traditional supply-demand analysis.

## Insights

Limitations concerning the available data resources prevent a statistically meaningful analysis of occupational demand in the agriculture, environment, outdoor recreation, and natural resources economic sectors. Moreover, it is impossible to determine if a talent gap exists based on these quantitative data sources alone.

That said; the information collected from the 17 participating employers provides valuable data and perspective about employment and the need for skilled mid-level workers in the agriculture, environment, outdoor recreation, and natural resources sectors in the state. Although the limited scope of the study sample means that these findings cannot statistically represent the entire population of Washington employers, the results do serve to underscore some of the broader challenges associated with relying on existing federal and state-level employment and workforce-related data for these industries, which in turn is used to prioritize and award federal, state and local investments in workforce education and training initiatives. Exploring options for enhancing and improving the accuracy, quality, and currency of available data is a prudent action step that will help ensure that future investments in education and training in skilled mid-level career preparation aligns with the employment and skill needs of industry, while enhancing the preparation and career options for students and current workers in these important industry sectors and occupations.

## Cross-Industry Analysis of 17 Companies interviewed

The rich data content collected from each employer also enables a more complete understanding of the primary needs and concerns identified by employers regarding employment in skilled, mid-level jobs, including the technical knowledge and skill requirements, general workplace competencies, and career opportunities. While the sector and job-specific themes and requirements are described in each intact section of the report, a number of these findings cut across the four sectors and many job types. While additional research should be conducted to supplement and confirm the implications for employers, employees, and workforce education, these findings may provide potentially important clues

about the current and future knowledge and skill needs of employers and the workforce. Some of those crosscutting findings are summarized below:

## **Technology and Automation**

By far, the most common topic raised by employers when asked about important trends in their industry was the use of advanced technology. Many employers expressed their need for new and existing workers to have or acquire technology skills, and most reported their concern that applicants often lacked necessary skills and experience using these technologies. While a broad range of technologies were described, and many uses and applications are occupation-specific, the most frequently-reported types were related to two general categories:

1. Production and process automation, such as PLCs, robotics, and related computer-controlled systems and integrated technologies, that are used to plant, harvest, process, package, store or transport products, such as agricultural products. These technologies are used primarily by companies to achieve high levels of productivity and product quality.
2. The use of scientific tools such as GIS/GPS and other analytics software to navigate, monitor, collect, measure and analyze data, and apply those findings to enhance the ability of an organization to actively manage an important asset or resource, such as timberlands. These technologies are used broadly, but a primary goal is to ensure that the scientific methods used to monitor, support, and manage resources are accurate and contribute to an organization's resource management plan.

## **Technical Skills**

Virtually all employers described the need for employees to understand, use and adapt to advanced technology in the workplace. This was a prominent theme reported by employers for nearly all skilled mid-level job types. Depending on the specific job type, employer remarks about the use of technology as a technical skill ranged from basic computer and software use (Microsoft suite), to the use of sophisticated control systems and programming. Although the specific technologies and levels of technical skill identified by employers vary considerably by job type, the current and future need for mid-level employees to understand and adapt to computer-based technologies and tools was universal; many employers noted that computer-driven technology is so prevalent in their production operations and business systems that it is understood as a general, transferrable skill set that cuts across many related job types and sectors.

## **Systems Thinking**

Employers in each of the sectors rely increasingly on technology—including production automation, integrated software tools, and data-driven analytics. These technologies have become increasingly sophisticated and integrated across technical and functional domains (telecommunications, IT, scientific and operations), and employers in turn have also come to expect employees to have a systems-view of how these advanced technologies, processes

and departments work together in their organizations. Although many of the job types require employees with specialized knowledge and skill, higher levels of technical and workplace integration are driving many employers to value employees who also have a holistic view of their jobs and an interdependent workplace that is necessary for organizational success.

## **Multi-Skilling**

Many employers reported that they are also looking for employees who have skills in more than one functional area. This was especially true for production and maintenance-related job types, such as millwrights, mechanics and even electricians, where technical knowledge and skills that cut across mechanical, electrical and electronic components and systems are valued because they enable effective and efficient maintenance and repairs to ongoing production operations. These positions are also commonly found in many industrial settings and organizations, thus these skills are highly transferrable among sectors. Several employers noted that even non-production jobs are becoming increasingly multi-skill and interdisciplinary, with increasing levels of collaboration and crossover between functions and departments. Forestry technicians, for example, perform a myriad of scientific and technical support work, but they may also interact regularly with biologists, environmental engineers, foresters, and managers.

## **Foundational Workplace Competencies**

Regardless of whether the skilled mid-level jobs identified by employers were regarded as highly experienced, technical and specialized, supervisory, or more generalist and entry-level, there was an overriding emphasis on the need for general workplace competencies. Many employers stressed that these basic workplace competencies are an essential dimension that they consider during the hiring process and for advancement. Although many different workplace competencies were identified by employers, and there was some variation by sector and job type, some of the most frequently mentioned competencies include the following: The ability to communicate effectively in writing, digitally, verbally, and with individuals and groups from a wide range of backgrounds and levels, including other employees, managers and customers, having the ability to work as part of a team, as a contributor and team-player, problem-solving and critical thinking skills were often emphasized by employers for nearly all job types and sectors; personal qualities such as having a good work ethic, a positive attitude, a willingness to take initiative, and being honest and ethical, were also emphasized by employers.

## Recommendations

### Standardize Alternative Sector Definitions

Establish transparent guidelines on how existing data should be used to make workforce development policy and program decisions to offset the deficiencies in high-level employment and occupational demand data. There is no one solution; policy-making and program decisions should be considered through a lens with multiple stakeholders and data sources in mind. Programs designed to inform and prepare workers for career opportunities should be aligned with the needs and practices of local employers.

Standardizing definitions of composite sectors could also help clarify the conditions facing industries that are connected through a shared value chain, such as natural resources and wood product manufacturing.

### Enhanced Data Reporting

#### Systematic Quantitative Approaches

The ability to accurately inform and prepare workers for job opportunities depends on detailed information about the occupational makeup of current employment. Options to routinely acquire this data need to be developed and evaluated, for example, the possibility of expanding the data reported by employers through the unemployment insurance system.

If UI wage reports included the SOC code for each of their employees, then it would be possible to know the precise makeup of Washington's worker-occupational makeup. If employee birth year were also reported at time of hire, forecasting of retirement impacts by area and occupation would become feasible. SOC codes are linked to descriptions of the required skills and responsibilities for each occupation. This occupational information, together with existing employer industry data (NAICs codes), would make possible better projections of occupational changes and occupational demand within any industry at a regional level. There are significant issues of protecting proprietary information that would have to be addressed in any such process of data collection.

Another issue with SOC codes is the changing nature of work. SOC codes are not updated rapidly nor regionally specific, and may not accurately describe the reality of workers taking on evolving and/or multi-functional roles. In this respect, the reported occupational makeup based on SOC codes alone, may not accurately reflect the skill demands of employers.

This data could be further supplemented by making use of web-crawler services that aggregate online job postings, which provides current information on the skill content and occupational composition of labor markets across different industries and regions

## Systematic Qualitative Approaches

Surveys are another means of collecting information surrounding occupational information, which could be conducted at either an individual or firm level as a supplement to the current system. These surveys could be further supported by focus groups and interviews designed to provide greater context around skills-demand. However insightful these activities may be, there would still be limitations regarding sampling, such as sample size and response rate, which can restrict how representative a sample may be from the population at large.

Developing a sentinel network is another approach. The healthcare industry in Washington experienced similar dilemmas concerning skills gaps and worker shortages for certain healthcare occupations. As a partial solution, a 'Sentinel Network'<sup>47</sup> has been established.

A similar system could be adopted for the Agriculture, Natural Resources, Environment, or Outdoor Recreation sectors... or for that matter, any sector facing such workforce development and information challenges.

## Skills-Based Approach to Assessing talent gaps

Workforce development policies and programs should explore targeting transferable skills in addition to occupations when addressing occupation-specific talent gaps. Job titles and occupations are continually redefined, with workers taking on additional roles and responsibilities beyond the scope of what is defined in any official taxonomy for occupations. Moreover, jobs requiring similar skill sets can have different titles between industries, further complicating demand and supply estimation. As demonstrated in this report, reliance on a single data source can lead to questionable conclusions. An analysis of a variety of complimentary data sources, both quantitative and qualitative, would paint a picture that is more likely framed in reality.

## Next Steps

Any further studies related to this report, such as assessing employment opportunities for workers with skill levels above or below mid-level, should first develop a standard methodology for defining what exactly constitutes agriculture, natural resources, environment, and outdoor recreation sectors. This is a key next step in developing a consistent assessment methodology for these industries. For example, should forestry and logging, which is normally classified under agriculture – along with its cousin industries further up or down the supply chain – be examined separately from other facets of the natural resources sector, or be included? It may be preferable to treat the entire forestry universe separately because of its outsized economic weight relative to other natural resource industries. In any case, the 'composite' sectors called out in this report should first be carefully and officially defined, before any further analysis.

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<sup>47</sup> The Workforce Training and Education Coordinating Board, "Washington State Health Workforce Sentinel Network". <http://www.wtb.wa.gov/HealthSentinel/>

## Appendix 1: Steering Committee Members

Name	Organization
Alan Hardcastle	Washington State University, WSU Energy Program
Cheryl Fambles	Pacific Mountain Workforce Development Council
Dennis Wallace	Office of the Superintendent of Public Instruction
Eric Gonzalez	Washington State Labor Council
Kathryn Kurtz	Pacific Education Institute
Leslie Druffle	The McGregor Company
Lindsey Williams	Agriculture Center of Excellence
Lisa Perry	Sierra Pacific Industries
Marcus Roberts	Tieton Cider Works
Mary Catherine McAleer	Weyerhaeuser
Mike Racine	Big Tent Outdoor Recreation Coalition
Peter Guzman	State Board for Community & Technical Colleges

## Appendix 2: Full List of All Skilled Mid-Level All Job Titles Reported by the 17 Interviewed Employers

Job Titles by Industry	Employment	Job Vacancies	New Hiring, Next 3 Years	Retirement, Next 3 Years
<b>AGRICULTURE</b>				
Accounting Administrator	1	0	0	0
Associate Performance Excellence Manager	1	0	0	0
Electro-Mechanic	5	1	1	0
Electro-Mechanic A	3	1	1	0
Maintenance Electrician	1	1	1	0
Maintenance Technician	1	0	0	0
Waste Water I	1	0	0	0
WWPP Resource	2	0	0	0
Ag Scientist	1	0	0	0
Accounting Clerk	11	0	15	1
Assistant Plant Manager	4	1	3	0
Performance System Manager	1	0	0	0
Line Mechanics (Maintenance Engineers)	93	4	33	3
Loadout/warehouse Supervisor	1	0	0	0
Maintenance Planner	2	0	0	0
MRO Buyer	1	0	0	0
Payroll Coord	2	0	0	0
Performance Based Trainer	1	0	0	0
Production Planner	2	0	0	0
Production Supervisor	36	3	3	1
Sanitation Supervisor	1	0	0	0
Lab Tech	1	0	1	0
Mechanic	1	0	0	0
Production	4	1	5	0
Cider Maker	1	0	0	0
Process Mechanics	19	0	0	6
Packaging Mechanics	7	0	0	4
Refrigeration Mechanic	8	0	0	3
Electricians	7		0	1
Process Control Technician	2	0	0	1
PSM Coordinator	1	0	0	0
System Service Technician	1	0	0	0
Service Technician (45-2091)	87	11	8	10
Service Center Manager (45-1011)	8	0	2	2
Plant Nutrition-Reactor (17-2021)	1	0	1	0

Equipment Division-Fabricator (17-3027)	8	0	2	4
Plant Protection-Blender (17-2021)	1	0	1	1
Seed Mill/Warehouse (17-3028)	5	2	2	2
Service Manager (45-1011)	22	0	7	7
IT Technician/User Support (15-1232)	3	0	2	0
Crop Advisor (Account Manager)	33	2	8	8
<b>Total</b>	<b>391</b>			
<b>ENVIRONMENTAL</b>				
Tree Improvement Technician	1	0	0	0
Tree Regeneration Technician	1	0	1	1
Minor Forest Product Technician	1	2	2	0
Timber Sale Administration Technician	0	0	2	0
Roads Technician	0	0	1	0
Pre-Sale Technician	0	1	2	0
Administrative Technician	0	0	1	0
Inventory Technician	3	0	0	0
Clerk	2	1	1	0
Assistant Fire Fuels Management Specialist	1	0	0	0
Fire Dispatcher	1	0	0	0
Wildlife Intern	1		-1	0
Water Quality Tech	2	0		0
Forest Practice Tech	3	0		0
Botany Tech	3		-1	0
QDNR (Natural Resources) Intern	1	1		0
High School Interns-summer, part time	6			
Wire Electrician	19	4	6	2
Line Electrician Sr	17	4	12	8
Administrative Assistant	17	2	7	5
Equipment Mechanic, Heavy	14	1	6	5
Engr Technician III	11	0	3	3
Management Analyst I	10	2	2	0
Hydro Project Electrician	9	0	2	2
Hydro Project Mechanic	9	1	6	5
Engr Technician II	8	2	3	1
Engr Technician IV	8	0	0	0
Electrical Inspector	7	2	5	3
Line Clearance Tree Trimmer	6	1	4	3
Electrical Meter & Relay Tech	6	0	2	2
Financial Assistant	6	0	2	2
Systems Power Dispatcher Generation	6	0	4	4
Computer Support Technician	7	0	2	2
Utility Service Specialist	5	0	2	2

Grounds Maintenance Crew Leader	4	0	1	1
Broadband Services Technician	2	2	3	1
Conservation Program Coordinator	3	0	0	0
Facilities Maint Mechanic	3	0	2	2
Systems Power Dispatcher 108.06% Coord	3	0	1	1
Telecom Tech Services Supv	3	0	2	2
Project Maintenance Technician	3	0	0	0
Broadband Services Technician, Lead	2	1	2	1
Telecom Technical Administrator	2	0	0	0
Electrician	2	0	1	1
Line Clearance Tree Trim, Sr 3% ISA	2	0	1	1
Chief Surveyor, Asst	1	0	0	0
Machinist	1	0	0	0
Park Supervisor Asst	1	3	3	0
Transmission & Distrib Flagger	1	0	0	0
Conservation Program Associate	1	1	1	0
Survey Technician III	1	0	0	0
Line Crew	42	3	5	5
System Operator	11		3	3
Electronic Tech	7		2	2
Electric Shop Tech	12		5	5
Dispatch Generalist	1			
Power System Electrician	12		1	1
Fiber Field Service	4		1	1
Dispatcher	1			
Administrative Assistant	20		1	1
Equipment Operator	1		1	1
Station Operator	1			
Line Patrolman	1		1	1
Power Plant Operator	37	1	6	6
Hydro Mechanic	45		10	10
Power Plant Foreman	2		1	1
Power Plant Electrician	27		4	4
Plant Manager	1		1	1
Foreman-Fleet Services	1			
Fleet Mechanic	8			
Engineering Technician 1	1	0	5	0
Engineering Technician 2	9	2	3	4
Wastewater Collection System Specialist 1	3	0	0	1
Wastewater Collection System Specialist 2	4	0	0	1
Engineering Technician Apprentice	0	6	6	0
Engineering Permit Technician	0	0	0	0
GIS Technician	0	0	0	0
<b>Total</b>	<b>477</b>			

<b>OUTDOOR RECREATION</b>				
Maintenance Supervisor	1	0	0	0
Maintenance Mechanics	6	2	2	0
Tooling and Fabrication Supervisor	1	0	0	0
Tooling and Fabrication Lead	1	0	0	0
Tooling and Fabrication Coordinator	1	0	0	0
Mfg Engineers 1	2	0	0	0
Automation Electrician	1	0	0	0
Production Supervisors	5	0	2	0
Config Control	2	0	1	1
QA Tech	2	0	0	0
QA Receiving Tech	1	0	0	0
Repair Supervisor	1	0	0	0
Repair Techs	4	0	3	0
Testing Specialist	1	0	1	0
Lab Tech	1	0	0	0
CAD Specialist	1	0	0	0
R and D Specialist Prototyping	1	0	0	0
Project Manager	2	0	1	0
Help Desk IT Support	1	0	1	0
Top Managers/(Sr. Guides)	2			
Shop Manager	1			1
Floor Manager	1			1
Shop Associates	5		10	
Guides (Subcontractors)	10			
Guides/Retail	2			
Reservations	1			
Parts - CAD	2		1	
Parts - Cutting	2		3	
Parts - Material Handling	1		2	
Parts - Machine Operator	7	1	4	
Parts - FAB	6	1	3	
Welding - Jig Welding	37	6	20	4
Paint/Prep - Prep	8	1	4	
Paint/Prep - Paint	10	2	5	2
Finish - Wood & Carpet	5		3	
Finish - Rigging	13	3	5	1
Finish - Top Shop	2		2	
Finish - Top Install	2		2	
Finish - Detail	3	1	3	
Electrician	3	0	0	0
Lift Maintenance Mechanic	11	0	0	2
Vehicle Maintenance Mechanic	5	1	0	1

IT Technician	0	1	0	0
Electrical Manager	3	0	0	0
Lift Maintenance Manager	1	0	0	1
Carpenters	2	0	1	0
Building Maintenance Manager	1	0	0	1
Vehicle Maintenance Manager	2	0	0	1
<b>Total</b>	<b>183</b>			
<b><i>NATURAL RESOURCES</i></b>				
Millwright	102	10	20	9
Electrician-PLC	7	2	3	0
Electrician	22	8	10	2
Grader - Certified	4	0	2	2
Welder	2	0	1	0
Mechanic	15	4	5	1
Truck Driver	61	15	15	5
Designer-Mechanical	2	0	1	0
Forestry Technician	3	0	4	0
Millwright	69	2	18	14
Electrician-PLC	3	0		0
Electrician	31	3	7	5
Mechanic	44	1	4	4
Truck Driver	93	2	10	8
Log Scaler	32	0	5	4
Fish Technician II	18	3		
Fish Technician III	11			1
Fish Technician IV	7			3
Fish Technician V	0	0		
Fish Culturist II	13	0	1	
Fish Culturist III	6	0	1	
Fish Culturist IV	1	0	0	
Fish Culturist V	2	1	0	
Resource Worker I (Seasonal)	10	0	0	0
Resource Worker I (Furlough)	2	0	0	0
Resource Worker II (Furlough)	7	0	0	1
Resource Worker III (Furlough)	2	0	0	0
Resource Worker III	1	0	0	0
Forester Intern	0	1	0	0
Forester I	1	0	0	1
Forest Technician IV	2	0	0	0
Program Manager II (Project Supervisor)	1	0	0	0
Field Technician I	1	2	2	0
Field Technician II	2	3	3	0
Field Technician III	5	5	3	0

Field Technician IV	5	0	1	0
Field Technician V	1	1	1	0
Resource Worker I	1	0	0	0
Resource Worker IV	1	0	0	0
Habitat Fields Operator 1	1	0	0	0
Senior Habitat Tech	1	0	1	1
Archeological Tech	1	0	0	0
Special Projects Technician	0	1	1	0
Special Projects Coordinator	1	0	0	0
Office Assistant IV	1	0	0	0
Bookkeeper IV	2	0	1	1
Realty Specialist	1	0	0	0
Administrative Specialist	1	0	1	1
Boiler/Kiln Lead	7	1	2	0
Crane Operator	3	0	0	0
Electrician	8	1	2	0
Log Scaler	3	0	2	2
Mechanic 1	4	0	0	0
Millwright	34	3	5	2
Truck Driver	5	1	1	0
Forester	7	0	0	0
<b>Total</b>	<b>571</b>			
<b>TOTALS</b>	<b>1622</b>	<b>156</b>	<b>457</b>	<b>245</b>

## Appendix 3: Online Job-Posting Data Aggregated by Burning Glass for High Priority Jobs Identified by Interviewed Employers

High-priority jobs identified by employers in outdoor recreation were too general and disparate to provide a meaningful skills breakdown and are therefore not included

*High Priority Jobs Identified by Interviewed Employers in Agriculture, 2017*

Top 25 Required Specialized Skills	Job-Postings	Growth Category
Repair	4833	NA
Customer Service	2028	Similar
Hand Tools	1066	NA
Electrical Work	1044	Similar
Scheduling	915	NA
Welding	910	Similar
Customer Contact	873	Similar
HVAC	832	Similar
Predictive/ Preventative Maintenance	817	NA
Machinery	812	Similar
Sales	744	Similar
Plumbing	719	Similar
Electrical Systems	691	Similar
Product Knowledge	686	Similar
Schematic Diagrams	588	Slower
Process Improvement	549	Similar
Wiring	535	Similar
Test Equipment	522	Slower
Occupational Health and Safety	518	Similar
Power Tools	513	NA
Forklift Operations	513	Similar
Auto Repair	500	Similar
Budgeting	489	Similar
Retail Industry Knowledge	426	NA
Description and Demonstration of Products	422	NA

**Total Jobs-postings: 1,035**

**Average Demand Level**

**Source: Burning Glass, 2017 Full Year**

<b>Top 25 Required Skills Clusters</b>	<b>Job-Postings</b>	<b>Growth Category</b>
Maintenance, Repair, and Installation: Equipment Repair and Maintenance	817	Similar
Maintenance, Repair, and Installation: Basic Electrical Systems	245	Similar
Manufacturing and Production: Machinery	227	Faster
Customer and Client Support: Basic Customer Service	222	Much Faster
Maintenance, Repair, Installation: HVAC	179	Similar
Manufacturing and Production: Welding	178	Faster
Supply Chain and Logistics: Material Handling	174	Faster
Administration: Scheduling	164	NA
Maintenance, Repair, and Installation: Hand Tools	163	Similar
Maintenance, Repair, and Installation: Vehicle Repair and Maintenance	160	Similar
Maintenance, Repair, and Installation: Plumbing	158	Much Faster
Human Resources: Occupational Health and Safety	157	Faster
Architecture and Construction: Electrical Construction	117	Similar
Maintenance, Repair, and Installation: Schematic Diagrams	113	Similar
Health Care: Physical Abilities	113	NA
Maintenance, Repair, and Installation: Power Tools	112	Slower
Information Technology: Microsoft Office and Productivity Tools	108	Similar
Architecture and Construction: Carpentry	98	Much Faster
Maintenance, Repair, and Installation: Electrical and Mechanical Labor	97	Similar
Supply Chain and Logistics: Facility Management and Maintenance	78	Similar
Information Technology: Technical Support	72	Faster
Manufacturing and Production: Machine Tools	69	Similar
Engineering: Electrical and Computer Engineering	68	Similar
Education and Training: Training Programs	62	Faster
Maintenance, Repair, and Installation: Painting	61	Similar
<b>Unspecified</b>	<b>46</b>	

**Total Jobs-postings: 1,035**

**Average Demand Level**

**Source: Burning Glass, 2017 Full Year**

<b>Industry (2-digit NAICS)</b>	<b>Job-Postings</b>
Manufacturing	211
Real Estate and Rental and Leasing	101
Retail Trade	57
Transportation and Warehousing	54
Accommodation and Food Services	46
Educational Services	40
Public Administration	35
Administrative and Support and Waste Management and Remediation Services	33
Construction	31
Professional, Scientific, and Technical Services	15
Other Services (Except Public Administration)	15
Health Care and Social Assistance	13
Agriculture, Forestry, Fishing and Hunting	8
Finance and Insurance	7
Wholesale Trade	6
Utilities	2
Arts, Entertainment, and Recreation	2
Information	1
<b>Unspecified</b>	<b>372</b>

**Total Jobs-postings: 1,035**

**Average Demand Level**

**Source: Burning Glass, 2017 Full Year**

<b>County</b>	<b>Job-Postings</b>
King	493
Pierce	175
Snohomish	82
Spokane	46
Yakima	32
Franklin	29
Thurston	27
Grant	24
Clark	22
Benton	20
Cowlitz	17
Kitsap	11
Lewis	10
Chelan	10
Kittitas	7
Whatcom	5
Adams	5
Skagit	3
Mason	3
Walla Walla	2
Pacific	2
Island	2
Grays Harbor	2
Clallam	2
Jefferson	1
<b>Unspecified</b>	<b>2</b>

**Total Jobs-postings: 1,035**

**Average Demand Level**

**Source: Burning Glass, 2017 Full Year**

*High-Priority Jobs Identified by Interviewed Employers in Natural Resources, 2017*

*\*Excluding Truck Drivers*

<b>Top 25 Required Specialized Skills</b>	<b>Job-Postings</b>	<b>Growth Category</b>
Electrical Work	945	Similar
Repair	738	NA
Hand Tools	333	NA
Electrical Systems	323	Similar
Wiring	311	Similar
Schematic Diagrams	267	Slower
Test Equipment	240	Slower
Welding	237	Similar
Machinery	222	Similar
HVAC	201	Similar
Transformers	174	Slower
Predictive/ Preventative Maintenance	130	NA
Power Tools	128	NA
Electrical Diagrams/ Schematics	127	NA
Plumbing	120	Similar
Forklift Operation	114	Similar
Scheduling	105	NA
Renovation	102	Similar
Electrical Engineering	97	Similar
Circuit Breakers	96	Similar
Programmable Logic Controller (PLC) Programming	94	Slower
Electrical Wiring	93	Similar
Machining	91	Similar
Computer Numerical Control (CNC)	89	Slower
Roofing	88	Similar
Unspecified	195	

**Total Jobs-postings: 1,217**

**Average Demand Level**

**Source: Burning Glass, 2017 Full Year**

Top 25 Required Skills Clusters	Job-Postings	Growth Category
Maintenance, Repair, and Installation: Basic Electrical Systems	968	Similar
Maintenance, Repair, and Installation: Repair and Maintenance	440	Similar
Maintenance, Repair, and Installation: Hand Tools	339	Similar
Maintenance, Repair, and Installation: Schematic Diagrams	321	Similar
Architecture and Construction: Electrical Construction	304	Similar
Manufacturing and Production: Welding	253	Faster
Manufacturing and Production: Machinery	237	Faster
Maintenance, Repair, and Installation: HVAC	222	Similar
Maintenance, Repair, and Installation: Power Tools	220	Slower
Architecture and Construction: Construction Management	191	Similar
Manufacturing and Production: Computer-Aided Manufacturing	183	Much Faster
Energy and Utilities: Electrical Power	168	Similar
Maintenance, Repair, and Installation: Electrical and Mechanical Labor	159	Similar
Human Resources: Occupational Health and Safety	150	Faster
Manufacturing and Production: Machine Tools	145	Similar
Maintenance, Repair, and Installation: Plumbing	134	Much Faster
Supply Chain and Logistics: Material Handling	131	Faster
Customer and Client Support: Basic Customer Service	121	Much Faster
Architecture and Construction: Carpentry	115	Much Faster
Engineering: Electrical and Computer Engineering	109	Similar
Administration: Scheduling	105	NA
Architecture and Construction: Conduits	102	Similar
Business: Project Management	89	Much Faster
Architecture and Construction: Roofing	88	Faster
Human Resources: Recruitment	87	Much Faster
Unspecified	283	

**Total Jobs-postings: 1,217**

**Average Demand Level**

**Source: Burning Glass, 2017 Full Year**

Industry (2-digit NAICS)	Job-Postings
Construction	557
Manufacturing	244
Public Administration	73
Educational Services	54
Agriculture, Forestry, Fishing and Hunting	40
Professional, Scientific, and Technical Services	37
Administrative and Support and Waste Management and Remediation Services	29
Utilities	26
Transportation and Warehousing	26
Retail Trade	17
Real Estate and Rental and Leasing	17
Wholesale Trade	13
Health Care and Social Assistance	13
Accommodation and Food Services	13
Other Services (Except Public Administration)	11
Finance and Insurance	5
Arts, Entertainment, and Recreation	5
Information	2
Unspecified	249

**Total Jobs-postings: 1,217**

**Average Demand Level**

**Source: Burning Glass, 2017 Full Year**

County	Job-Postings
King	435
Pierce	133
Snohomish	113
Spokane	79
Clark	77
Kitsap	63
Franklin	37
Benton	34
Thurston	30
Yakima	27
Skagit	24
Lewis	24
Chelan	22
Cowlitz	20
Island	12
Grant	10
Mason	9
Whatcom	8
Kittitas	8
Grays Harbor	8
Ferry	8
Stevens	6
Pacific	5
Pend Oreille	4
Okanogan	4
Unspecified	1

**Total Jobs-postings: 1,217**

**Average Demand Level**

**Source: Burning Glass, 2017 Full Year**

*High-Priority Jobs Identified by Interviewed Employers in Environment, 2017*  
*\*Excluding Clerks*

<b>Top 25 Required Specialized Skills</b>	<b>Job-Postings</b>	<b>Growth Category</b>
Repair	265	NA
Schematic Diagrams	103	Slower
Heavy Equipment	94	Similar
Test Equipment	79	Slower
Technical Support	76	Similar
Scheduling	74	NA
Civil Engineering	73	Faster
Computer-Aided Drafting/ Design	66	Similar
Engineering Drawing	65	NA
Project Management	61	Similar
AutoCAD	53	Similar
Calibration	52	Similar
Welding	50	Similar
Microstation	48	Similar
Engineering Support	47	Similar
Machinery	44	Similar
Electrical Systems	44	Similar
Hand Tools	42	NA
Calculation	42	NA
Wiring	41	Similar
Soldering	41	Similar
Engineering Design and Installation	36	NA
Engineering Design	36	Similar
Cost Estimation	36	Similar
Power Tools	35	Similar
Unspecified	70	

**Total Jobs-postings: 674**

**Average Demand Level**

**Source: Burning Glass, 2017 Full Year**

Top 25 Required Skills Clusters	Job-Postings	Growth Category
Engineering: Drafting and Engineering Design	210	Much Faster
Maintenance, Repair, and Installation: Repair and Maintenance	176	Similar
Information Technology: Microsoft Office and Productivity Tools	158	Similar
Information Technology: Technical Support	114	Faster
Engineering: Engineering Practices	113	NA
Maintenance, Repair, and Installation: Schematic Diagrams	112	Similar
Maintenance, Repair, and Installation: Heavy Equipment	99	Similar
Business: Project Management	97	Much Faster
Maintenance, Repair, and Installation: Basic Electrical Systems	96	Similar
Maintenance, Repair, and Installation: Electrical and Mechanical Labor	87	Similar
Engineering: Civil and Architectural Engineering	81	Similar
Administration: Scheduling	74	NA
Administration: General Administrative and Clerical Tasks	69	Faster
Human Resources: Occupational Health and Safety	65	Faster
Business: Contract Management	61	Similar
Manufacturing and Production: Welding	57	Faster
Architecture and Construction: Estimating	56	Similar
Manufacturing and Production: Product Development	53	Similar
Engineering: Engineering Software	53	Similar
Business: People Management	50	Similar
Manufacturing and Production: Machinery	47	Faster
Maintenance, Repair, and Installation: Hand Tools	47	Similar
Manufacturing and Production: Machine Tools	46	Similar
Business: Business Process and Analysis	44	Faster
Customer and Client Support: Basic Customer Service	43	Much Faster
Unspecified	147	

**Total Jobs-postings: 674**

**Average Demand Level**

**Source: Burning Glass, 2017 Full Year**

Industry (2-digit NAICS)	Job-Postings
Public Administration	147
Professional, Scientific, and Technical Services	120
Manufacturing	92
Real Estate and Rental and Leasing	30
Educational Services	19
Utilities	15
Retail Trade	14
Construction	14
Other Services (Except Public Administration)	10
Transportation and Warehousing	9
Wholesale Trade	8
Administrative and Support and Waste Management and Remediation Services	6
Health Care and Social Assistance	5
Accommodation and Food Services	5
Finance and Insurance	4
Information	3
Mining, Quarrying, and Oil and Gas Extraction	2
Unspecified	170

**Total Jobs-postings: 674**

**Average Demand Level**

**Source: Burning Glass, 2017 Full Year**

County	Job-Postings
King	232
Clark	109
Snohomish	63
Kitsap	57
Pierce	48
Spokane	63
Benton	25
Whitman	19
Yakima	15
Whatcom	9
Kittitas	8
Franklin	8
Grant	7
Island	6
Cowlitz	6
Walla Walla	5
Thurston	5
Skagit	5
Lewis	5
Mason	2
Garfield	2
Grays Harbor	1
Douglas	1
Columbia	1
Chelan	1
Unspecified	0

**Total Jobs-postings: 674**

**Average Demand Level**

**Source: Burning Glass, 2017 Full Year**