

# San Diego Maritime Industry Report 2012

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San Diego Workforce Partnership  
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## A Maritime Vision for San Diego

San Diego is a maritime city - it is a desert city that is made unique by its presence on one of the most beautiful bays and coastlines in the world. It is a world-class port city with a Maritime Industry that represents one of the most unique regional economies in the world with more than 1,400 companies producing over \$14 billion of direct sales and a workforce of almost 46,000 spread across an array of traditional and technology-oriented sectors. And San Diego benefits by its location as the pivot point to the Pacific – the largest, deepest ocean in the world – which ties it emotionally, intellectually and physically to the growing markets of Asia and Latin America. The oceans are the future of the world – covering 66 percent of the world's surface - sustainable usage of the ocean will be increasingly critical to produce the food, water, energy, medicine, and coastal “real estate” needed for the growing world population, over 80 percent of which lives near the oceans. The Pacific represents not a border but a frontier with enormous growth opportunity for San Diego. The fast-growing Maritime Technology Cluster has benefited from the traditional industry's presence, and the two need to collaborate to “be all they can be”. This is a massive opportunity that will require the development of a vision, education, enlightened regional leadership, and a community effort to achieve the possible.



## Executive Summary

San Diego's Maritime Industry and related economic activity comprise the regional **"Blue Economy"**.<sup>1</sup> Along with its functional sub-set, the maritime technology or **"Blue Tech"** cluster, it is one of the most unique regional economies in the world. When the totality of San Diego's maritime activities are accounted for, they reach across nearly 200 separate NAICS (North American Industry Classification System) codes and include businesses in sectors as obvious as fishing and as surprising as metal forging. These widely varying occupations support multiple sectors and represent a sustainable competitive advantage for the region. Note that although the **Blue Economy** would include non-industrial economic activity such as the hotels and restaurants on the Port Tidelands, for the purpose of this report, **"Blue Economy"** shall be used interchangeably with "Maritime Industry" when referring to the totality of the maritime industries and related economic activity in three general categories as defined below.

The region's focus on the high-technology aspects of the **Blue Economy** is increasingly well-placed. Technology is becoming ever more enmeshed in even the most traditional maritime activities. While an increased injection of technology is true of nearly every corner of nearly every economy, part of what makes the process different in maritime businesses is just how uniquely and wholly maritime the technologies are. There are other sectors that are changing in this way, such as agriculture or construction, but the evolution is not just about workers using computers; it is about the kinds of computers they are using. The role of technology in San Diego's maritime economy is also unique because of the close relationship with the U.S. Navy and the need for innovation for the Defense Department and defense industries.

The more that San Diego's policy and maritime business leaders can understand their shared interests, opportunities, and challenges in the face of these technological changes, and the more understanding and collaboration that can develop in an industry which is both driven by and drives globalization, the more an individually distinct source of regional strength will grow.

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<sup>1</sup> The Maritime Alliance defines **"Blue Economy"** as "the sum of all economic activity having to do with oceans, seas, harbors, ports and coastal zones." The Maritime Alliance used the work of Dr. Judith Kildow as published by the National Ocean Economics Program in *The National Report: State of the U.S. Ocean and Coastal Economies, 2009* as the basis for its definition.

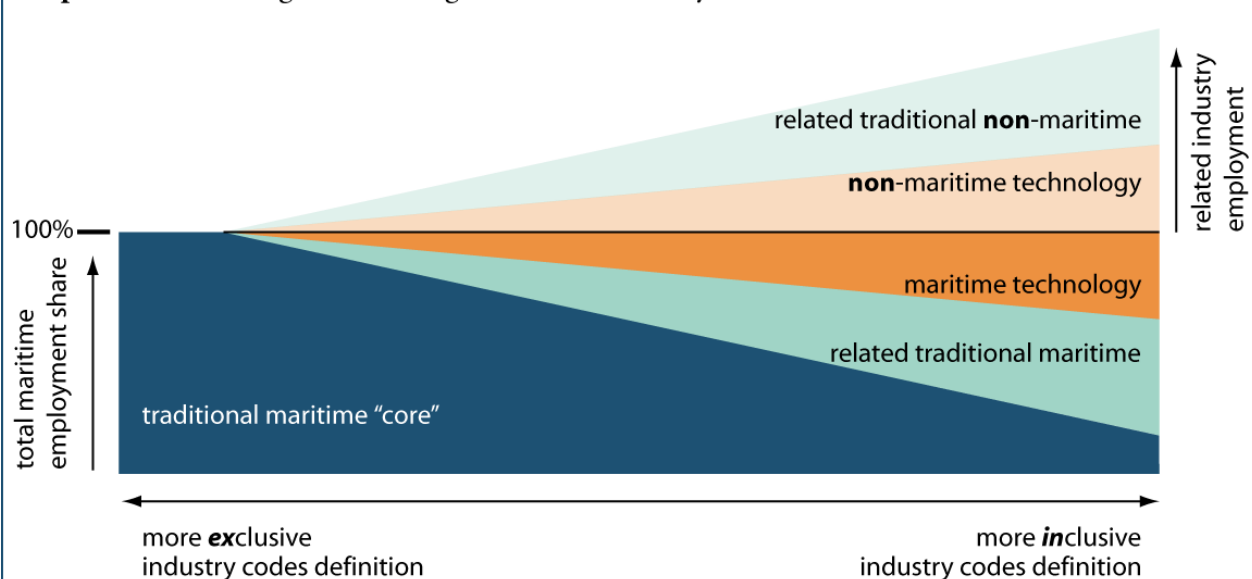
That effort, though, must necessarily confront the "evil twin" of all this uniqueness: the simple fact that many of these technologies and occupations are "emerging"; current industry codes and official occupational classifications are generally ill-suited to fully capture the uniqueness of the San Diego maritime industry and, especially, the **Blue Tech** cluster.

This project conceived of the **Blue Economy** in three general categories, which can be perceived as a functional organization of San Diego's Maritime Industry.

- ▶ The traditional maritime space, in which industries are exclusively maritime, such as fishing and ship building
- ▶ The traditional maritime space, in which an industry includes maritime and non-maritime activity, such as construction industries capable of working on ports
- ▶ The maritime technology space, or **Blue Tech**

The critical issue is that the latter two categories include, within the same official industry code, both maritime AND non-maritime activity. This issue can be visualized with the following graphic.

**Graphic 1.** Visualizing the San Diego Maritime Industry



**note:** Selected codes came from a variety of sources, described below. The assignment of industry codes as tech / non-tech, as well as to sub-clusters was conducted by ERISS, which bears sole responsibility for them.

**source:** ERISS; World Trade Center San Diego, *Maritime Economic Impact and Cluster Analysis*; The Maritime Alliance; Info-USA; Dun and Bradstreet; CorporateWiki.

Using data from proprietary business resources (such as Info-USA and Dun and Bradstreet), standard data from the BLS and Census Bureau, and, critically, first-hand information from ERISS interviews and both a telephone and an online survey, this project's first task was to determine which industries belonged to which functional category in Graphic 1, as well as which parts of a given industry were maritime and which were not. That effort, in turn, allowed the project to determine:

- ▶ The Maritime Industry's overall contribution to the local economy
- ▶ The industry's subcategories and respective percentages of the overall total
- ▶ The industry's business and workforce development needs, and
- ▶ The industry's interest in engaging with strategic industry partnerships and intermediary collaborations to further business retention, expansion and new business recruitment

The entire project represents the results of a research survey of the vast industrial sectors of San Diego's **Blue Economy** and was sponsored by the San Diego Workforce Partnership (SDWP), the San Diego Regional Economic Development Corporation (SDREDC), and The Maritime Alliance (TMA).

The project was conducted by San Diego-based ERISS Corporation over a period of four weeks during May and June 2012. It involved quantitative economic analysis, numerous in-person and telephone interviews, and both a telephone and an online survey.

In total, the analysis suggests an estimated 46,000 employees work in San Diego's Maritime Industry.

- ▶ Approximately 8,000 of these are in traditional, exclusively maritime industries
- ▶ Approximately 19,000 work in **Blue Tech**
- ▶ Approximately 18,700 work in traditional industries that include maritime activities but are not exclusively maritime
- ▶ Total revenue is estimated at slightly more than \$14 billion (direct spend only)
- ▶ Based on feedback, the projected total employment growth between 2011 and 2020 is for nearly 6,000 new jobs, or 12 percent of the current total (though fast growth, new technologies, and new opportunities could yield significantly higher numbers)



- ▶ The location quotient, or relative concentration of San Diego's maritime industries compared to the U.S. as a whole, was high for the vast majority of sectors, particularly those in **Blue Tech**

For industries that include both maritime and non-maritime activity, non-maritime employment and revenue is excluded from these estimates. Of course, these estimates necessarily differ in degree from other estimates that have been done for the region's maritime economy; however, given the difference in time periods, the far more expansive industry code list used for this project (partly a function of including most of the codes involved in The Maritime Alliance's directory), and the use of a survey to estimate maritime function within industries, the estimates would seem well within the range of other efforts. San Diego's leaders should feel comfortable about the general size of this portion of the region's economy.

Once the project had developed the functional understanding of the Maritime Industry described above, it then sought to estimate data for the different categories that make up the total industry. In other words, it is critical for the region to be able to determine what its **Blue Economy** does: from fishing to science. The template that the project used was the sectors that have been identified by The Maritime Alliance.

### **A Note on the Economic Impact of the Port of San Diego and Multiplier Effects**

One of the largest traditional maritime entities, the Port of San Diego is the fourth largest of California's eleven public ports and has jurisdiction over approximately 5,500 acres of land and water in and around San Diego Bay. The Port's maritime industrial segment includes two cargo terminals, two cruise ship terminals and maritime industrial tenancies such as ship repair and ship building facilities, and cargo processing and distribution.

The Port's economic contribution to the region should be noted as studies demonstrate significant positive employment impacts of the Port's maritime businesses, with 14,950 direct jobs and 42,280 total jobs generated (Port of San Diego Economic Impact Study, ERA 2007). Cargo operations result in 1,817 direct jobs and 19,298 total jobs (Maritime Business Plan Update, TEC 2008). Cruise operations result in 1,088 direct jobs and 2,243 total jobs (Port of San Diego Economic Impact Study, ERA 2007).

A previous Port study found a multiplier effect of 2.82 for Port economic activity. This relatively high regional multiplier (in general, regional multipliers range below 2.0) reflects the relatively high wages and the fact that Port activity is dominated by firms in the tradable goods and services industries. A significant portion of the direct employment estimated in this study is in **Blue Tech**. Some analysts suggest that high-tech multipliers may be closer to 5 or 6.<sup>2</sup> Without detailed local analysis, such multipliers appear excessively large. Nonetheless, research does indicate that high technology industries have higher than average multipliers – they are high wage, tend to be tradable, have a relatively high R&D concentration, and are often associated with high localization at various points of the supply chain (which could plausibly be especially true of **Blue Tech**, because of its unique maritime nature and its overlap with telecom)—all of which support higher regional multipliers, on average. A complete economic impact analysis may show the total economic impact (i.e., direct, indirect and induced) of the San Diego Maritime Industry to be some 120,000 jobs and possibly much larger.<sup>[1]</sup> Further research is recommended.

This research would finally determine a NAICS-based description of the industry that becomes the standard model for each stakeholder, and would also seek to establish the supply chain (input-output) dynamics of the industry so that indirect and induced economic impact estimates have an informed and widely accepted base for analysis.

The chart on the next page shows the results of the project's employment analysis for each sector.

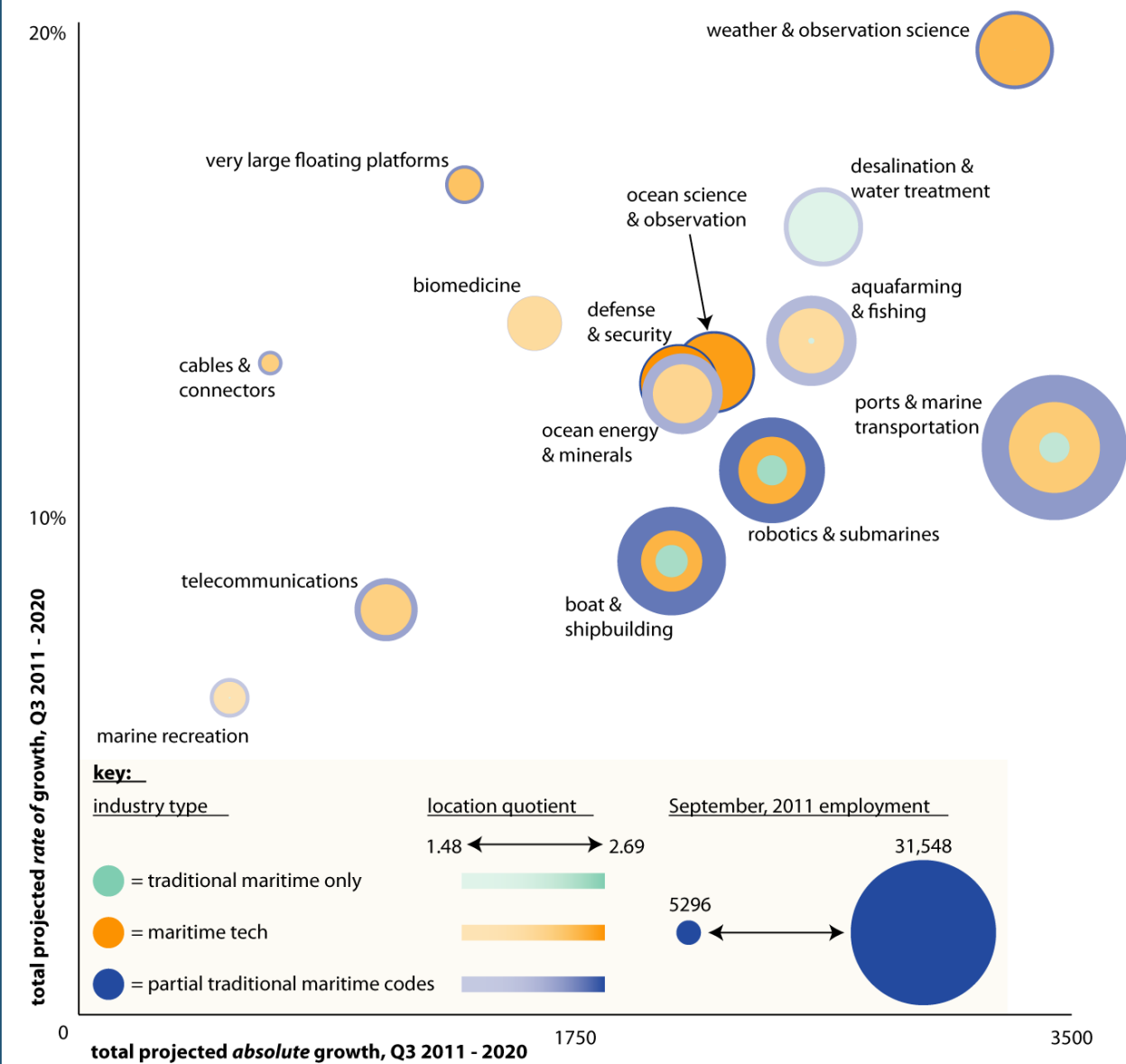
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<sup>2</sup> Enrico Moretti, "Local Multipliers". *American Economic Review: Papers & Proceedings* 100 (May 2012).

<http://www.brookings.edu/blogs/the-avenue/posts/2012/08/23-multiplier-effects-muro>

This is a very crude estimate using the assumptions that Port direct employment stayed constant at 14,950, and had the same multiplier as previously estimated. Blue tech employment was 19,000. Some of this would be included in the Port employment and no estimates of R&D intensity, average wages or NAICS code-specific multipliers were undertaken. To be cautious we use the same Port multiplier of 2.82. For the remaining maritime employment we use a more typical rule of thumb multiplier of 2.0. This works out to an average multiplier of 2.61.

**Graphic 2.** Industry employment dynamics of the San Diego Maritime Industry



**note:** Total employment of individual subclusters will exceed total employment of the *entire* cluster, due to industries' inclusion in multiple sub-clusters.  
**source:** U.S. Bureau of Labor Statistics, *Quarterly Census of Employment and Wages*; U.S. Bureau of Labor Statistics, *Employment Projections Program*; ERISS; The Maritime Alliance, World Trade Center San Diego, *Maritime Economic Impact and Cluster Analysis*, November 30, 2009.

While these sub-clusters were designed with the maritime technology space in mind, there are a number of reasons to begin to look to them as a way of understanding the entire Maritime Industry.

- *New is old:* Many categories were always applicable to the traditional parts of the maritime economy.

- ▶ *Old is becoming new:* The growing role of technology is erasing the barriers between traditional maritime and maritime tech.
- ▶ *Form to function:* Since a major goal for the region should be to devote scarce resources in a way that maximizes return on investment, establishing a common understanding of the entire **Blue Economy** helps clarify shared interests and opportunities.

As mentioned, these findings are based in part on the results of a survey of local employers. Almost exactly half reported a maritime focus as part of their business, with more than one-quarter of the total indicating that more than 75 percent of their business was maritime-related.

A clear occupational pattern emerged with respect to which occupations are most "critical" or important to the industries. The pattern represented a bifurcation between high-paying jobs that require extensive education and jobs that do not require a bachelor's degree and are at the heart of the traditional purview of the workforce development community, yet are also high-paying. This is an obvious function of the way that the entire industry includes both traditional and high-Tech functions.

Despite the bifurcation of the type of occupations that employers are most concerned with, there was widespread uniformity about the type of training they use to ensure their workers have the skills that are required in today's maritime economy. More than half of employers indicated they used both internal and external sources of training. Compelling, though, and of importance to the Workforce Partnership, employers were likely to rate their own internal training programs more favorably than external programs. This could offer an opportunity for the Partnership to target and align its support for employers that currently feel relatively ill-served by external training providers.

In addition, employers were more likely to cite industry-specific skills than cross-cutting work skills as the greatest deficiency among job candidates. This, too, suggests an area of need for the workforce development community's programs.

Other areas of opportunity for the Workforce Partnership exist in its mission to help place special populations in gainful employment. More than 90 percent of employers indicated a willingness to hire veterans, and nearly

three-fourths are willing to hire persons with disabilities. More than half are willing to hire ex-offenders.

However, the first challenge for the workforce development system is straightforward: helping employers understand what workforce programs exist and the nature of the assistance that the system can provide.

Approximately 85 percent of employers were not in any way familiar with these programs. These numbers provide the justification for a workforce strategy that has as its base a commitment to employer engagement and continued use of employer surveys as a vehicle for employer engagement. This strategy has an excellent return on investment (as opposed to traditional marketing or public relations efforts).

Expanding to the subject of the larger economy and region, San Diego's assets were cited as strengths by the region's maritime businesses. When asked the reasons for locating in San Diego, the second-most popular answer was "quality of life", while the most popular answer was "close to customers", a large number of whom are presumably in the region because of its quality of life. The third most common reason was access to the Port of San Diego.

While the above are the most important factors that support local maritime businesses, employers also shared concerns. Unsurprisingly on the heels of one of the worst recessions in modern economic history, macroeconomic decline was the major headwind that employers feel they confront. The second most common concern is highly related: greater domestic competition (with greater international competition another major worry).

The concerns over macroeconomic decline will hopefully ease in the months and years ahead (though the situation in Europe and recent hints out of Beijing are an increasing worry for shipping and logistics operations at the Port). However, the issue of competitiveness can be directly addressed with policy action.

As discussed above, a central responsibility of the project was to assess the environment for greater collaboration among maritime firms. Interviews suggest that the general attitude toward collaboration is positive; however, the unique nature of so many of San Diego's maritime businesses is seen as reducing the potential for shared group action. Identifying commonality and shared potential should be an important goal for regional leaders.

One method for doing so is emphasizing sectors and sub-sectors and key elements that have broad implications for the entire Maritime Industry. The most obvious candidates, based on the analysis and interviews, are (in alpha order) defense procurement, desalination & clean water Technologies, logistics & shipping, maritime robotics, ocean energy, seafood and aquaculture, and shipbuilding and repair.

At this point, maritime businesses are heavily focused outside the region for both their supply chains and for sales of non-final, consumer goods. Strategies to highlight local supply chain opportunities should be a priority.

There were a number of group activities explicitly mentioned by interviewees, such as assistance with defense procurement, joint marketing, facilities sharing, and shared R&D efforts. There are regional examples of best practices from which San Diego can draw.



## Defining the San Diego Maritime Industry

For a variety of reasons, a cluster based in maritime activity is harder to define than most clusters. Most obviously, over 90 percent of all freight moves over the ocean so maritime impacts virtually all aspects of the economy, from agriculture to manufacturing to shipping. With a more straightforward cluster—the entertainment cluster of Los Angeles, for example—identifying the industries and economic activity at the heart of the cluster is fairly straightforward. The choice of what to include in a more diffuse industry grouping involves subtler judgments. This requires walking a conceptual tightrope between identifying all the parts of the economy that are relevant, on the one hand, and avoiding an over-stuffed muddle of industry codes, on the other hand.

This difficulty has grown more acute over time. The maritime space is becoming increasingly technologically sophisticated. Bucolic images of fishing boats emerging from the morning fog with the day's catch, or even less bucolic images of the rough-and-tumble docks, have given way to both uses of the sea and means of use that were unimaginable only a few years ago.

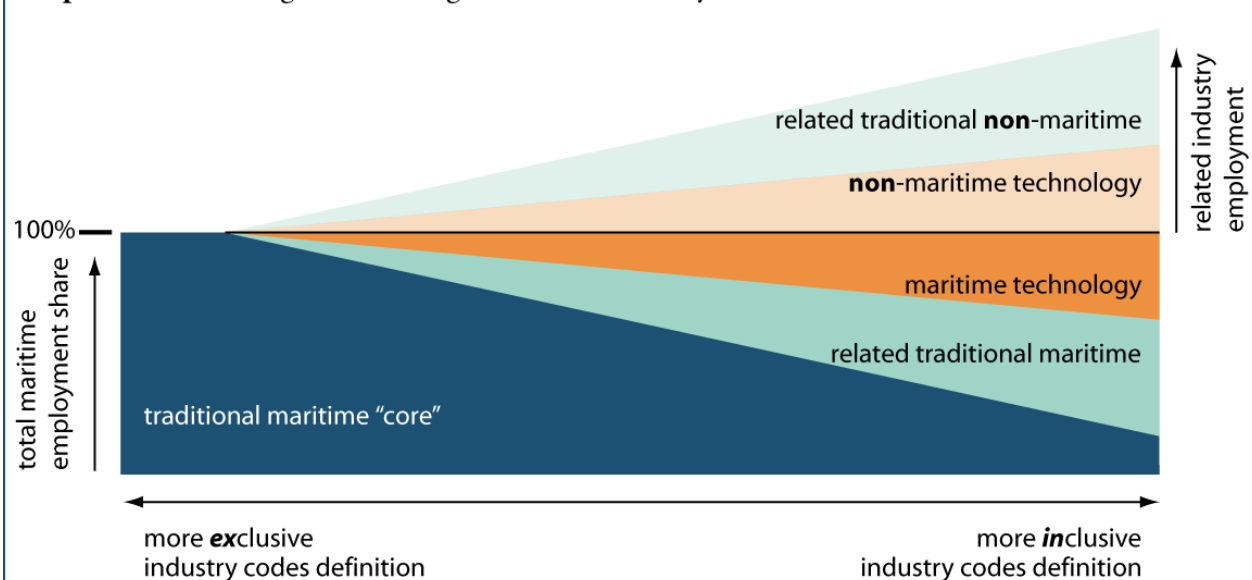
The evolution toward increasing technological sophistication means casting an ever wider net in defining the maritime space. High-Tech goods and services are not simply in the supply chain of maritime activity. They are at the very heart of maritime activity itself. These types of maritime firms may not be assigned an industry code traditionally associated with the water, but they must be considered in the industrial cluster analysis, all the same.

This is particularly true for San Diego. San Diego is home to a unique dedicated industry organization, The Maritime Alliance, which is explicitly focused on the maritime *technology* or **Blue Tech** space. In addition, TMA did not emerge by accident; the San Diego region is home to a particularly intense maritime technology community. It hosts one of the most technologically intensive naval defense communities on the planet. It is home to research and development efforts for a wide range of ocean-related activities, including one of the top-rated oceanographic institutions in the world. And it is the birthplace of multiple technologies and disciplines in the maritime realm.

As a result, for purposes of this report, we have referred to the collective maritime industries as the **Blue Economy** (or Maritime Industry) and to the **Blue Tech** sub-set as the Maritime Technology Cluster.

In total, then, the San Diego **Blue Economy** involves three types of industries. Their relationship is shown in Graphic 1.

**Graphic 1.** Visualizing the San Diego Maritime Industry



**note:** Selected codes came from a variety of sources, described below. The assignment of industry codes as tech / non-tech, as well as to sub-clusters was conducted by ERISS, which bears sole responsibility for them.

**source:** ERISS; World Trade Center San Diego, *Maritime Economic Impact and Cluster Analysis*; The Maritime Alliance; Info-USA; Dun and Bradstreet; CorporateWiki.

**Traditional Maritime “Core” Industries**– The first type of industry is the most obvious: an industry that deals more or less exclusively with maritime activity. Examples would include fishing, ocean shipping, ports, etc. The total employment and revenue of these industries were included in the analysis for this project.

**Related “Traditional” Maritime Industries**– The second type involves industries that include maritime activities but are also associated with non-maritime goods and customers. For example, port construction is so specialized as to include construction firms that are unquestionably maritime in focus. However, the industry codes that categorize such firms would also include many other construction businesses that are not maritime in nature. Estimating the maritime-related share of employment and revenue of these industries was a major undertaking of the project.

**Maritime Technology Industries**– The third category of industries includes businesses that are central to the Maritime Technology activity in San Diego. These industries’ relationships to the maritime space take two forms, in terms of whether they are wholly or partially maritime and whether they are wholly or partially Maritime Technology industries.

**High-Tech but only partially maritime**– The industrial sectors within this category include firms that are both maritime and non-maritime in their focus. However, the maritime firms within the industry are more or less exclusively focused on Maritime Technology or their activities are high-tech-intensive. A common example for this category is research and development firms. Multiple spheres of research are focused on maritime issues; however, the firms that do such research are categorized with general research industries. University-based research is an obvious specific example.

**Wholly maritime but only partially Maritime Technology** – This category describes industry sectors that only include maritime businesses, although those businesses may or may not be Maritime Technology-focused. For example, services to ocean-borne shipping involve maritime-only codes, but can include both low- and high-tech activity.

In the first sub-category, a main responsibility of the project was distinguishing between maritime and non-maritime businesses. However, with respect to the second sub-category, there were admittedly instances in which there was no practical way to distinguish between maritime firms that were high-tech and those that were low-tech.

Moreover, as will be discussed at length later in the report, there are important policy reasons to avoid overemphasizing the distinctions between Maritime Tech and traditional maritime. The two are often so closely inter-related that workforce and economic development policy for the one is best pursued in the context of policy for the other.

Graphic 1 also refers to “maritime related” industries. For this project, the concept amounts to the non-maritime portions of the identified industries, as described above. It is important to note that, while this portion of the relevant industries is important for the overall vitality of San Diego's maritime and maritime technology businesses, their employment and revenue were NOT considered for this project. The simple reality is that far too many codes were necessarily included in the definition of the Maritime

Industry. Adding the employment bases of non-maritime businesses, even in the same industry codes as maritime firms, would have made the analysis unworkable and detracted from its value and utility.

While the overall result of the various categories—traditional maritime, maritime technology, and the nature of the related industries—creates a community that is defined in a unique manner, this does not mean that the definition is somehow invalid; quite the contrary. The industries that were ultimately selected as maritime industries were chosen with great care. To every extent possible, the entirety of San Diego's maritime business is represented. A significant effort was made to distinguish between maritime and non-maritime businesses within the same industry code, where necessary. They and the "supporting industries" thus include the full array of businesses that drive the competitive advantage of the **Blue Economy** in San Diego.

**The Port of San Diego** – Although historically rooted in the traditional maritime industry, the Port of San Diego and its economic activity cut across the categories identified above. The Port is the fourth largest of California's 11 public ports and has jurisdiction over approximately 5,500 acres of land and water in and around San Diego Bay. Within this area, the Port operates two deep-water cargo terminals and two cruise ship terminals. The two cargo terminals, the Tenth Avenue Marine Terminal and the National City Marine Terminal, are located in the region's working waterfront area, the center of the industrial activity occurring in San Diego Bay. Port maritime industrial businesses are located between the two terminals including shipbuilding and repair, auto processing, transportation of goods, and manufacturing. These businesses, which are linked to the Port's maritime operations, are port tenants that provide goods and services that support the region's maritime activity. The cruise ship terminals are located in the North Embarcadero area of downtown San Diego.

Studies demonstrate significant positive employment impacts of the Port's maritime businesses, with 14,950 direct jobs and 42,280 total jobs generated (Port of San Diego Economic Impact Study, ERA 2007). Cargo operations result in 1,817 direct jobs and 19,298 total jobs (Maritime Business Plan Update, TEC 2008). Cruise operations result in 1,088 direct jobs and 2,243 total jobs (Port of San Diego Economic Impact Study, ERA 2007)

## San Diego Maritime Cluster Industries

As discussed above, The Maritime Alliance has undertaken yeomen's efforts to define the totality of the Maritime Technology Cluster – really a sub-set of the larger **Blue Economy** – similar to how maritime technology clusters around the world seem to identify their industry activity as an innovation industry with close and overlapping relationships to the spheres of traditional maritime activity. Their efforts resulted in 14 sectors for the San Diego Maritime Technology Cluster map with many sub-sectors.

- ▶ Aquaculture and Fishing
- ▶ Biomedicine
- ▶ Boat and Shipbuilding
- ▶ Cables and Connectors
- ▶ Defense and Security
- ▶ Desalination and Water Treatment
- ▶ Marine Recreation
- ▶ Ocean Energy and Minerals
- ▶ Ocean Science and Observation
- ▶ Ports and Marine Transportation
- ▶ Robotics and Submarines
- ▶ Telecommunications
- ▶ Very Large Floating Platforms
- ▶ Weather and Climate Science

### General Observations about San Diego Blue Tech<sup>3</sup>

- ▶ Highly differentiated industry – 14 sectors in San Diego; 71 sub-sectors
- ▶ Prevalence of multi-use technologies from small, specialized firms
- ▶ Typically high gross margins
- ▶ Largely self-reliant – traditionally modest users of bank debt and outside equity
- ▶ Largely invisible in local markets / limited public & government awareness
- ▶ Little baseline economic data due to non-specific NAICS codes
- ▶ Highly export-oriented – typically 40-60 percent for most companies
- ▶ Markets exist in virtually every country around the world
- ▶ Growth in most sectors strongly outpaces world economic growth

<sup>3</sup> Characterizations provided by The Maritime Alliance based on cluster experience

While developed specifically for the Maritime Technology Cluster by The Maritime Alliance, the same sectors can largely be used to describe the overall Maritime Industry. Doing so also helps to emphasize the increasing connectedness and overlap between the traditional and technology dimensions of San Diego's maritime businesses. Ultimately, this should better position San Diego's policy community to leverage shared assets and opportunities, from formal investments all the way to informal instances of collaboration among stakeholders.

Graphic 2 utilizes these sector descriptives to illustrate employment dynamics in the **Blue Economy**. There is significant industry overlap among the sectors, of course. For example, the construction capacity required to expand the ocean energy and minerals sector, which includes off-shore drilling, is highly similar to the construction capacity at the heart of the Very Large Floating Platforms sector. So, prior to examining Graphic 2, it is important to consider data for the industry as a whole.

- ▶ For industries that are traditionally in the maritime space and only in the maritime space (e.g., fishing), estimated employment was just over 8,000.

**Table 1.** Key industry diagnostics for the San Diego Maritime Industry

<b>Total employment (September, 2011)</b>	<b>45,778</b>
Traditional maritime exclusive industries	8,176
Maritime technology industries	18,948
Other maritime	18,654
<b>Total estimated revenue (September, 2011)</b>	<b>\$14,034,085,362</b>
Traditional maritime exclusive industries	\$ 1,403,082,257
Maritime technology industries	\$ 6,165,840,257
Other maritime	\$ 6,465,162,848

**Source:** ERISS; Info-USA; U.S. Bureau of Labor Statistics, *Quarterly Census of Employment and Wages*; Dun and Bradstreet; Corporation Wiki



- ▶ For maritime technology industries, many of which include non-maritime activity (e.g., bio research), estimated employment was slightly less than 19,000. (It should also be noted that maritime technology industries can include the applications of high technology in industries as traditional as fishing.)
- ▶ For industries that can include maritime activity but also other activity, or would be associated with a more expansive concept of the sectors listed earlier, employment was slightly less than 18,700.

In all, this project estimates total employment in San Diego's Maritime Industries at almost 46,000 workers (in September, 2011). Total revenue was estimated at more than \$14 billion. Note that the revenue figure is for direct sales only; no induced or indirect spending was considered.

Since this project covers similar terrain to a recent economic impact study<sup>4</sup> for San Diego's maritime industries, it is worth discussing the general nature of how industry codes, or portions of industry codes, were determined to be maritime-related. The process was a multi-step one. In cases such as fishing, of course, the issue was straightforward. For other industries, the project had two sources of data.

The first source was the telephone and online surveys. Since respondents were asked to assign the share of their business that was maritime-related, these results were used as a proxy multiplier for the industries that were part of the survey universe.

The second source was the TMA list. Since it could be reasonably assumed that all those on The Maritime Alliance list would be maritime businesses, industry codes were assigned to all possible, and employment and revenue were then ascertained from proprietary databases.

As a whole, then, for an industry that would not be wholly maritime, employment from TMA members was set aside, if relevant, and the residual multiplied by the proxy multiplier described above. This number was then added back to TMA employment to generate an estimate for total employment.

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<sup>4</sup>World Trade Center San Diego, *Maritime Economic Impact and Cluster Analysis*, November 30, 2009.

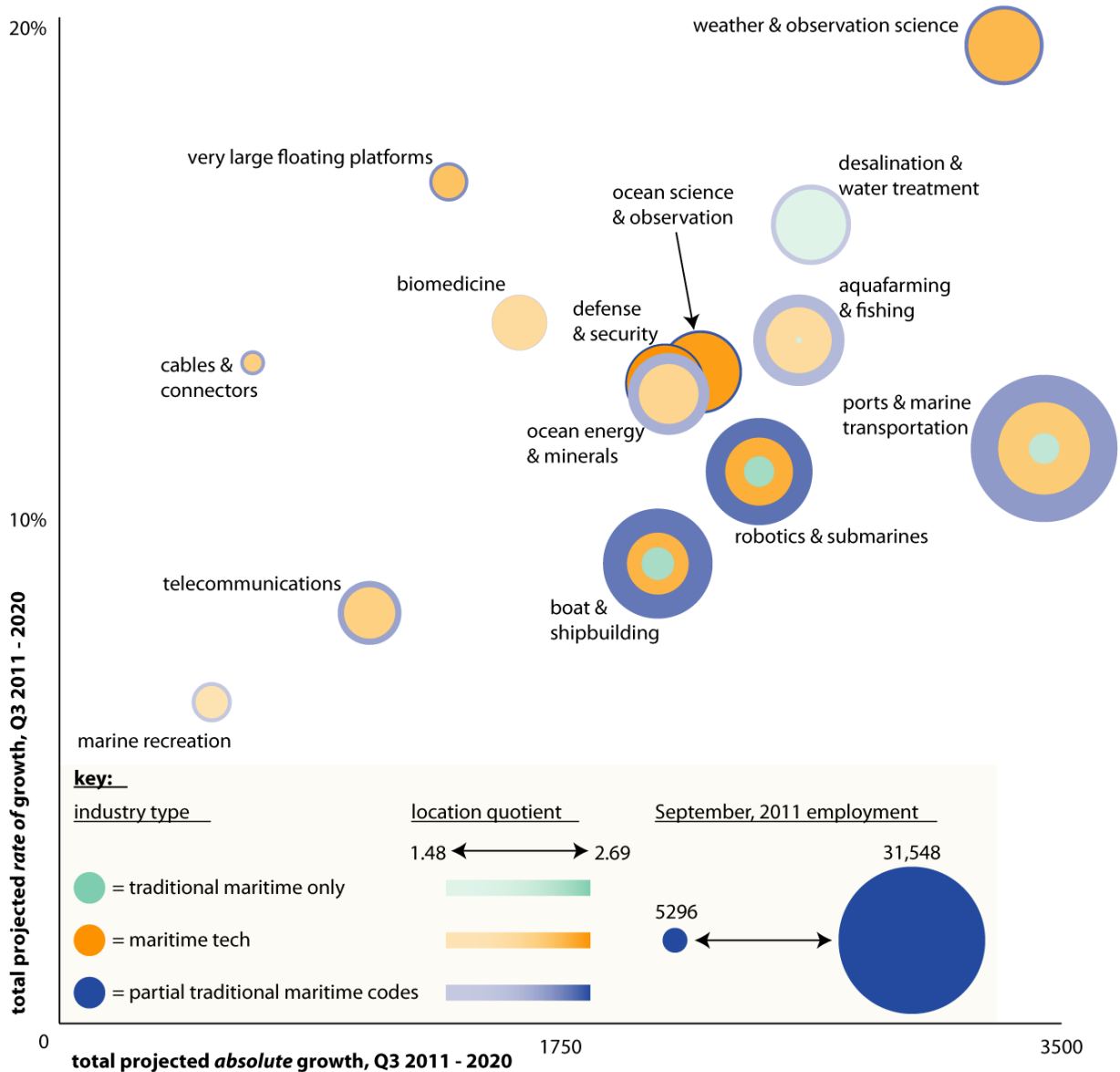
Given the complexity of the process, the fact that each study's methodology was developed in isolation, and the unique natures of the various proprietary employment databases, the general similarity among the data in Table 1 and the recent economic impact study (2009) is a welcome and encouraging result for all concerned.

Of course, each project also includes a different set of industry codes, with the larger list for this project driving the higher base employment figure. The unique choice of codes extends to their use in Graphic 2, a completely unique effort to understand all of The Maritime Alliance's sectors from the perspective of industry employment data.

A number of different data elements are depicted:

- ▶ Total employment (the circles' sizes)
- ▶ The employment of the different types of maritime industries within each sub-industrial category (e.g., "traditional maritime), which is represented by the nesting of colored circles for each sub-cluster
- ▶ Projected 2011 – 2020 absolute growth (the horizontal axis)

**Graphic 2.** Industry employment dynamics of the San Diego Maritime Industry



**note:** Total employment of individual subclusters will exceed total employment of the *entire* cluster, due to industries' inclusion in multiple sub-clusters.  
**source:** U.S. Bureau of Labor Statistics, *Quarterly Census of Employment and Wages*; U.S. Bureau of Labor Statistics, *Employment Projections Program*; ERISS; The Maritime Alliance, World Trade Center San Diego, *Maritime Economic Impact and Cluster Analysis*, November 30, 2009.

- ▶ The location quotient relative to U.S. total private employment (the intensity of the colors in each circle). As mentioned earlier, it is critical to understand that there is significant industry overlap among the individual sectors. Nonetheless, a number of issues in Graphic 2 merit special discussion.
  1. As might be expected, the two sectors arguably most associated with the Port (marine transportation and shipbuilding) are associated with the largest employment. These two sectors include a number of different types of activities and, thus, industries.
  2. Weather & observation science, though smaller than some of the other sectors, is associated with very strong diagnostics. In fact, climate change is the biggest driver of growth in the ocean science & observation sector, followed by offshore energy exploration, and defense & security.<sup>5</sup>
  3. The data for maritime recreation is generally unsurprising, given the nature of the other sectors, but the results for telecommunications may be disappointing to some. One mitigating factor for telecommunications may be a particularly wide gap between the realities of government industry codes and the unique nature of San Diego's maritime telecommunications firms; as a home to globally known telecommunications firms comprising one of the world's largest such clusters, the industry may be serving the maritime space, albeit not explicitly.
  4. The clustered group in the approximate rough middle of the chart suggests an opportunity to hit multiple sectors with cross-cutting economic and workforce development policy.
  5. Arguably the most important takeaway from Graphic 2 is just how bright the outlook is for each sector: high location quotients, strong relative and absolute growth, etc. Given many of the old-line industries, the uniformly positive data may be surprising to some.

Subsequent sections will explore a number of on-the-ground interview results and policy recommendations associated with the sectors.

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<sup>5</sup>Douglas-Westwood, *Global Markets for Ocean Observation Systems*, 2007.

While the variety of subjects addressed by this project limits the extent to which industry data can be explored in particularly great detail, it is important to note the industries associated with especially unique data. Table 2 lists the ten most important with respect to size and growth dynamics. Again, all data is *only* for the maritime portion of each industry.

**Table 2.** Key industries in the San Diego Maritime Industry

**Total employment (September, 2011)**

Ship Building & Repairing	6,127
<i>Testing Laboratories</i>	3,689
<i>R&amp;D in Physical, Engineering, &amp; Life Sciences (exc. Biotechnology)</i>	3,376
<i>Engineering services</i>	3,228
Search, Detection, & Navigation Instruments	1,973
<i>Plumbing &amp; HVAC Contractors</i>	1,935
<i>Other Management Consulting Services</i>	1,610
<i>Office Administrative Services</i>	1,157
Broadcast & Wireless Communications Equipment	1,004
<i>All Other Specialty Trade Contractors</i>	926

**Maritime share location quotients (relative to U.S. private employment)**

<i>Audio and Video Equipment Manufacturing</i>	11.98
Physical, Engineering, & Biological Research	7.25
<i>Broadcast &amp; Wireless Communications Equipment</i>	7.19
<i>Ship Building &amp; Repairing</i>	6.85
Marine Cargo Handling	6.79
Other Animal Aquaculture	6.28
Sporting & Athletic Goods Mfg.	6.17
<i>Musical Instrument Manufacturing</i>	5.52
<i>Testing Laboratories</i>	5.17
<i>Water Supply &amp; Irrigation Systems</i>	4.92

**Note:** *Italicized industries appear on more than one list*

**Source:** ERISS; Info-USA; U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; Dun and Bradstreet; Corporation Wiki

**Table 2 (cont.)** Key industries in the San Diego Maritime Industry**Total absolute growth (highest growth), 2011 - 2020**

<i>Testing Laboratories</i>	810
<i>Other Management Consulting Services</i>	742
<i>Engineering services</i>	709
<i>Plumbing &amp; HVAC Contractors</i>	435
<i>R&amp;D in Physical, Engineering, &amp; Life Sciences (exc. Biotech)</i>	344
<i>Office Administrative Services</i>	215
<i>All Other Specialty Trade Contractors</i>	208
Electrical Contractors	133
Medical Laboratories	131
Paint & Wall Covering Contractors	121

**Total absolute growth (lowest growth), 2011 - 2020**

Other Electronic Component Manufacturing	-6
Other Communications Equipment Manufacturing	-7
Other Lighting Equipment Manufacturing	-8
Finfish Fishing	-9
Other Household Goods Repair & Maintenance	-10
Instruments & Related Products Manufacturing for	
Measuring, Displaying, & Controlling Industrial Process Variables	-15
<i>Audio and Video Equipment Manufacturing</i>	-23
<i>Musical Instrument Manufacturing</i>	-83
Search, Detection, & Navigation Instruments	-171
<i>Broadcast &amp; Wireless Communications Equipment</i>	-228

**Note:** *Italicized industries appear on more than one list***Source:** *ERISS; Info-USA; U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; Dun and Bradstreet; Corporation Wiki*



## San Diego Maritime Industry Occupations

The explosion of cluster-based regional development interest over the last decade found a natural home (at least in theory) with economic development practitioners. If cluster theory's emphasis on specific industries was less catch-as-catch-can as many economic development groups had approached their charge, they nonetheless had the policy tools and experience required to target companies when these fit a cluster strategy's recommendations.

The implications for workforce development policy have not been such a comfortable fit. Some departments had a hard enough time trying to stay above water in the short-term as they coped with the day-to-day needs of workers or local businesses; yet cluster-based development requires a long-term vision matched with patience. Others were simply not given ample room at the table after a cluster strategy was positioned with dreams of luring the kind of workers who started companies, not career ladders. Nor was this a matter simply of what happened at the local level despite the theorists' best intentions.

The simple fact is that the traditional client of a workforce development department was simply not a part of the cluster discussion among very many people. However, this has begun to change. Healthcare cluster strategies around the nation have run smack into the need for technicians and housekeeping workers. A growing number of regions have realized that their best intentions are significantly affected by skilled manufacturing workers. Workforce development has a critical role to play when cluster strategies consider the practical challenges and opportunities within any region.

This is not to say that workers at the top of the income and education spectrum are no longer a central facet of what cluster strategies can offer a region. It is only to say that both spectrums are at the heart of what a region must emphasize in its cluster efforts. That fact is perfectly demonstrated by the results of the occupational analysis for the San Diego Maritime Industry.

An occupational strategy for the Maritime Industry must be necessarily unique. On the one hand, the industry composition is too diverse to look for industry-driven occupational patterns as a driving rationale. On the other

hand, that diversity includes both the kinds of firms that headline The Maritime Alliance's membership and those that rely critically on workers who are skilled but unlikely to hold a bachelor's degree.

Other parts of this report provide much more detail and go into greater depth in policy guidance. However, Graphic 3 introduces the issue as well as could any data analysis.

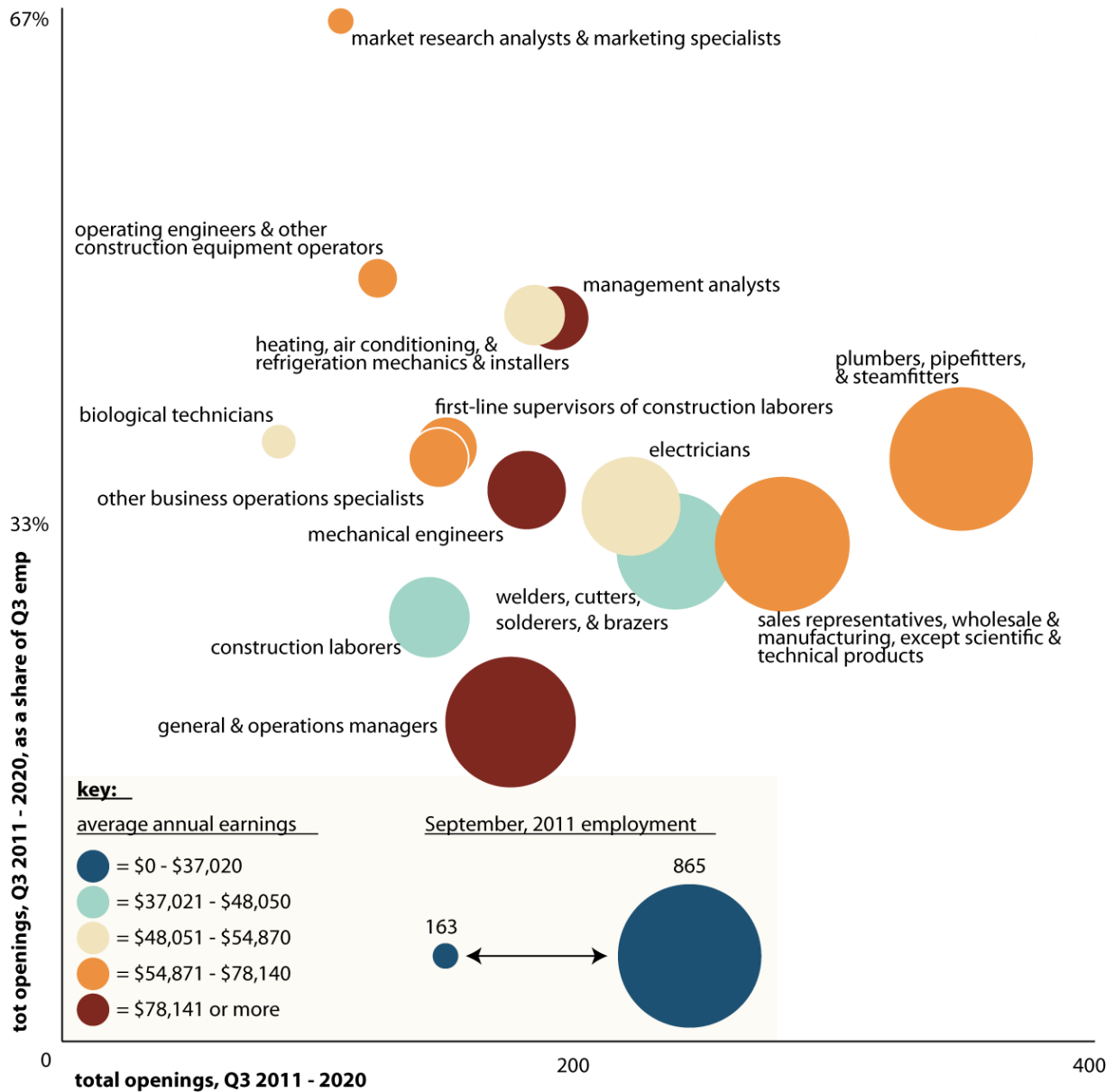
The occupations in Graphic 3 were chosen purely through objective quantitative analysis, with a partial exception.

- ▶ Occupations were scored according to their size dimensions: current employment, projected 2011-20 growth, and projected 2011-20 replacement needs.
- ▶ Among the highest scoring several dozen, another score was given for projected rate of growth (note: in general, the larger the occupation labor force, the slower the rate of growth).
- ▶ Again, the list was pared, after which a score was given for average annual wage.
- ▶ Finally a fairly clearly bifurcated list emerged, such that two partially arbitrary factors were considered: occupations that figured heavily in responses to the telephone survey and occupations that were associated with sub-bachelor's degree attainment in O\*Net.<sup>6</sup> However, these factors were considered only for a few of the occupations.

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<sup>6</sup>The O\*NET program is the nation's primary source of occupational information.

**Graphic 3.** Employment dynamics of critical occupations in the San Diego Maritime Industry



**note:** Employment is for the maritime-estimated portion of the occupation *only*.

**source:** U.S. Bureau of Labor Statistics, *Quarterly Census of Employment and Wages*; U.S. Bureau of Labor Statistics, Employment Projections Program and Occupational Estimates Survey; ERISS.

The results of Graphic 3 are perfectly consistent with the prior discussion about the two kinds of occupations that are critical to a cluster strategy and that absolutely necessitate a large role for the regional workforce development community.

- ▶ Occupations at the top of the education / wage spectrum include:
  - Market research analysts & marketing specialists
  - Management analysts
  - Mechanical engineers
  - Business operations specialists
  - General and operations managers
  
- ▶ Occupations within the traditional purview of workforce development include:
  - Operating engineers & other construction equipment operators
  - Heating, air conditioning, & refrigeration mechanics & installers
  - Electricians
  - Welders, cutters, solderers and brazers
  - Construction laborers
  - First-line supervisors of construction laborers
  - Biological Technicians

One of the most important lessons from Graphic 3 is the color accorded each occupation, which is to say the occupations' average annual wages. Not only are both types of occupations found on the list, both types of occupations are associated with very high wages.

Nor are wages the last rationale for the importance of workforce development in the maritime industry policy efforts. It is not as if any of these occupations are on a list of critical occupations in the industry for mysterious reasons. There is a strong ability to connect the occupations to industry need.

Again, subsequent parts of this report will explore the issue in more detail. However, as with the section on industry data, the next two tables list the most important occupations along several dimensions.

**Table 2.** Key occupations in the San Diego Maritime Industry

<b>Total employment (September, 2011)</b>	
Retail Salespersons	1,049
Plumbers, Pipefitters, and Steamfitters	922
Office Clerks, General	886
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	865
General and Operations Managers	839
Welders, Cutters, Solderers, and Brazers	747
Laborers and Freight, Stock, and Material Movers, Hand	662
Customer Service Representatives	648
Electricians	635
Bookkeeping, Accounting, and Auditing Clerks	615
<b>Total projected absolute growth, 2011 - 2020</b>	
Office Clerks, General	170
Management Analysts	137
Retail Salespersons	137
Plumbers, Pipefitters, and Steamfitters	129
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	126
Inspectors, Testers, Sorters, Samplers, and Weighers	119
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	111
Construction Laborers	108
Bookkeeping, Accounting, and Auditing Clerks	103
Customer Service Representatives	103

**Note:** *Italicized industries appear on more than one list*

**Source:** *ERISS; Info-USA; U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; Dun and Bradstreet; Corporation Wiki*

**Table 3 (cont.)** Key occupations in the San Diego Maritime Industry**Total replacement needs, 2011 - 2020**

Retail Salespersons	221
Plumbers, Pipefitters, and Steamfitters	212
Office Clerks, General	163
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	150
Customer Service Representatives	146
Laborers and Freight, Stock, and Material Movers, Hand	136
Inspectors, Testers, Sorters, Samplers, and Weighers	124
Management Analysts	119
Welders, Cutters, Solderers, and Brazers	118
Electricians	118

**Total openings (growth & replacement) from survey, 2012 - 2013**

Biological Technicians	150
Electricians	75
Construction Laborers	40
Civil Engineers	31
Customer Service Representatives	20
Electrical and Electronics Engineering Technicians	17
Operating Engineers and Other Construction Equipment Operators	15
Counter and Rental Clerks	14
Welders, Cutters, Solderers, and Brazers	13
First-Line Supervisors of Office and Administrative Support Workers	12

**Note:** *Italicized industries appear on more than one list*

**Source:** *ERISS; Info-USA; U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; Dun and Bradstreet; Corporation Wiki*



## **San Diego Maritime Employer Perceptions and Policy Recommendation**

This section reports San Diego maritime employers' perceptions, attitudes, and observations as expressed in interviews. These interviews were conducted both in-person and by telephone. Note that the telephone interviews should not be confused with the telephone survey.

Given the wide-ranging and in-depth nature of the interviews, as well as their number, the issues raised serve as an excellent introduction to the policy recommendations that arose from this project.

## Blue Economy Overview

### Global Focus

Among the firms interviewed there was a heavy concentration of companies with a very large customer base outside the region. Average exports were estimated at 36 percent of sales (median exports were 50 percent). However, these export estimates are misleadingly low. Sales to US firms are often in support of these firms' activities around the world.

- ▶ Very few of the companies interviewed have significant sales in the San Diego region and do not see themselves as part of an integrated regional community.
- ▶ Export earnings from maritime industries are an important source of net new income and wealth for the San Diego region.

Many of the maritime technology firms are in San Diego by historical accident. They tended to have spun out of the military or Scripps Institution of Oceanography. Indeed, several noted that the location was not ideal for their customer base.

- ▶ Many firms are very niche players with little or no regional customer base. This tends to the formation of closer business ties outside the region than locally.
- ▶ A number of firms interviewed are now part of large national or multinational firms. This reduces local decision-making authority and increases the risk that some or all of the activity might be relocated.
- ▶ Unless the region strengthens industry connections it may be at risk of losing some of the more successful firms with the weakest local business ties.

Most claimed that they used local suppliers, contractors, service providers when they are competitive or provide high quality or specialized products and services. Few of them had hard data on local purchases.

### Crosscutting Competitive Strengths

The firms collectively work with or design products/services with heavy engineering content. Further, even though the firms tend to see themselves

as niche players, they tend to have deep expertise – both in technology development and application, and operating in hostile marine environments (surface or subsurface) that can be leveraged broadly across industry sectors.

Many of the firms also report significant Information Technology and systems expertise or intellectual property as their primary product/service or as core to the competitive edge of their primary product /service.

### Common Trends/Challenges

Interviewed firms saw considerable opportunity, especially in offshore markets, but some of the most attractive deals are seen as too large or too complex for small companies to pursue effectively by themselves.

Strong global competition is emerging, especially from firms with considerable foreign government support or from large firms with access to significant private or public capital resources.

A large fraction of the firms expressed concerns about California's regulatory burden, as well as that of the U.S. Environmental Protection Agency (EPA).

Many firms were very concerned about threats to the working waterfront. They saw residential and tourism interests eating away at industrial and commercial uses of the waterfront.

The 12-month revenue and employment growth expectations were flat to positive. No one projected continued declines, though special concerns were expressed about the uncertainty of U.S. government budgets. A few firms had very positive outlooks, with growth expectations heavily biased to offshore locations and customers.

With some exceptions, the firms interviewed generally are not familiar with the SDWP. Some have limited knowledge of the SDREDC. Most have some knowledge of TMA, which is not surprising since TMA provided most of the interview contacts. The general lack of knowledge about SDWP and SDREDC activities and programs should be of concern.

Even among firms that know TMA, most claim to have an arm's length relationship. With limited exceptions, those interviewed tend to attend select events but are not very active, which is not surprising due to the recent establishment of the **Blue Tech** cluster, the broad differences in the 14 sectors, the lack of local involvement (i.e. outward orientation) of companies, and lack of recognition until very recently by city/regional authorities of the existence let alone the importance of the industry.

### Occupational challenges varied among types of firms

Most of the small, high-tech firms interviewed primarily recruited individuals with college or advanced degrees, with very high concentrations of various engineering disciplines.

- ▶ Firms reported considerable talent availability, particularly due to the recession.
- ▶ The primary recruiting concern was lack of maritime-specific experience and training. Lack of undersea experience was especially noted by several firms.
- ▶ A few firms expressed concern about a growing shortage of software developers and programmers.

Many firms noted that attracting the right talent to live in San Diego could be a significant challenge because of the very high cost-of-living. This was particularly important for manufacturing and assembly operations.

Product firms identified several additional, common themes.

- ▶ In general, regional product firms engaged in design and development, some prototyping, and at most limited, one-off or small-scale production with high value added. With some exceptions, larger volume manufacturing was sourced elsewhere.
- ▶ Talent requirements spanned the range of assembly, planning, procurement, testing and evaluation, etc.—all of which were identified as generally easy to recruit in the current economic environment (though out-of-region recruitment faced cost-of-living issues).
- ▶ Most product firms noted a reliance on unique niche processes and equipment that required specialized internal training. In general, however, if recruits had some technical skill and a good attitude, training was successful.

- ▶ Maritime-specific skills were a common gap that many firms struggled to overcome. This was of particular note in the efforts to replace the aging commercial fishermen and to fill shipyard requirements for specialized boat mechanics and certified welders.

## Markets of Special Interest

### Seafood: Aquaculture & Fishing Sector

Growth in global demand for seafood has created significant opportunity for expansion in both domestic consumption and export. San Diego has deep historical association with fishing, and the seafood industry is an important economic asset for the region.

- ▶ Although a fraction of its peak size, commercial fishing and processing remains an important local industry with growth potential.
- ▶ Sport fishing is one of San Diego's tourism anchors.
- ▶ Aquaculture has significant local R&D strength, and the San Diego region has the potential to host key components of the emerging value chain (technology development, hatcheries, transportation and processing, and marketing and distribution).

Commercial fishing in the region is much smaller than in its heyday, but observers believe that conditions are such that the industry has the potential to double in size over the next decade. Plans have been assembled to provide ongoing support for commercial fishing. These recommendations are incorporated in the recently released Commercial Fisheries Revitalization and Coastal Public Access Plan that has taken three years to complete.

The Board of Port Commissioners has directed the Port staff to begin implementation. Several million dollars must be raised, and implementation will take several years. With this infrastructure plan as a backdrop, it is important for other entities to begin to address complementary cluster issues. The Seafood Technology Sector Working Group of The Maritime Alliances seeks to promote regional collaboration by including both upstream and downstream activities, thus expanding its base.

Considerable synergy exists between what the fishermen and the seafood processing industry require and what is needed to make San Diego a center for aquaculture. The Commercial Fisheries Revitalization and Coastal Public Access Plan did not address aquaculture; *per se*. Interviews suggested that considerable aquaculture R&D strength exists in San Diego, but that the likelihood of developing a viable industry of any size in California waters is very low in the current regulatory environment.

A statewide effort to create more rational regulations and permitting processes that would support the development of an aquaculture industry in US waters is needed. In response to current regulations, the business models under discussion focus on keeping the R&D local and continuing to locally farm hatchlings for the purposes of stock replenishment, but creating the major aquaculture fisheries offshore from Mexico, where costs and government regulations are more favorable. One way to create significant economic activity for San Diego would be to capture the transport of farmed seafood to San Diego for processing and sale. Considerable work is required to assess the viability of such a strategy, determine necessary infrastructure, identify which economic and workforce development and other policy actions would be needed, and to work with the private firms that would be necessary to provide the required investment. Implementation of a broader, local aquaculture development strategy could add more than 5,000 jobs to the region.

### **Boat & Shipbuilding Sector**

Interviews suggest that boat repair and shipbuilding remains an important economic asset for San Diego. The Navy has been an important customer supporting this activity and is the reason that a major shipbuilder still exists on the U.S. Pacific Coast. The smaller yards have been investing in new capacity and are targeting larger vessels. Although the short-term outlook is flat, they expect strong long-term growth.

Several common issues emerged in the interviews.

California regulation on the larger private vessels was seen as an important impediment to super yachts, especially foreign flag, using San Diego yards for repair work. Essentially they fall under commercial, not recreational rules. The yards would like to see strong community support to help get these rules changed.

The yards all faced specific skill challenges. The yards would like to see some vocational programs that would provide more maritime-specific training and skills in general. Demand for two skill sets of specific importance emerged – marine mechanics and certified welders (with an ADS certification most important).



The yards interviewed are quite open to working with all competing yards and the community colleges to help develop appropriate programs. Some of the crosscutting skills required overlap with the needs of the fishermen. Indeed, lack of maritime exposure/experience/skills was a common concern among many interviewed firms.

### Defense & Security Sector

A large share of the companies interviewed have significant DoD revenues or are based on technology or expertise acquired from military activity. Among the small companies interviewed that had limited DoD involvement, many see the Navy as an important potential client.

Changes in defense priorities, especially Navy plans and programs raised several issues. Uncertainty concerning future budgets topped the list. However, opportunities were also clear. The small yards interviewed have seen significant Navy work – work that they expect to continue. Looking ahead, one company saw an opportunity for the creation of a West Coast depot maintenance facility for unmanned vehicles. More generally, several expressed an interest in the potential that will emerge as the Navy continues shifting from a 60-40 Atlantic-Pacific posture to a 40-60 Atlantic-Pacific orientation, due to be completed by 2020.

### Ocean Energy & Minerals Sector

Many of the companies interviewed have a strong focus on offshore energy, especially offshore oil and gas. This is a high-growth potential market. Even when offshore energy was not a current major customer focus, it was a priority potential target. Of the 14 maritime technology sectors identified by The Maritime Alliance, as many as nine intersect strongly in the ocean energy value chain.

Offshore energy, and potentially offshore minerals extraction, will be a dynamic economic sector for the foreseeable future. Companies with deep expertise and technologies focused on operations in hostile ocean environments, whether surface or subsurface, face an exciting array of opportunity. Indeed, one can argue that for at least six and as many as nine of the 14 **Blue Tech** sectors identified by TMA, the offshore energy and minerals exploitation value chain will be among their most robust potential

markets, although minerals extraction from sea beds is a market in its infancy.

For some one-third of the 22 companies that participated in live interviews, energy, especially offshore oil and gas, directly or indirectly, represented major, if not dominant customers. Others have technologies potentially relevant for offshore energy and mineral exploitation. Indeed, the universe of firms appears to have a great deal of potentially complementary technologies and core strengths. Most of these firms have few or no local customers. Their customers are either foreign firms or, if U.S. firms, located in either the Gulf of Mexico or foreign waters.

Although they serve the same or similar customer bases, most of these firms view themselves as insular, niche firms with little connection to the local market. Even though they tend to source some things locally, they have not traditionally seen themselves as a single industry or, in the case of **Blue Tech** companies, as part of a cluster. These firms tend to have historic and personnel reasons for being in San Diego, and so they must be viewed among those that might be at highest risk of outward relocation.

### Desalination & Clean Water Technology Sector

San Diego is the world leader in desalination technology. The reverse osmosis spiral module was patented in San Diego in 1964. More than 3,000 professionals and workers are employed by companies in the region which includes two of the three global market-share leaders in membrane supply. Desalination technology is a growth industry with high percentage of exports and good paying jobs locally. The worldwide desalination industry alone (without the broader clean water tech sector) was estimated at \$10 billion annually in 2010 and projected to expand to \$30 billion by 2016.<sup>7</sup>

San Diego is an ideal location to set up a Desalination and Clean Water Technology Center of Excellence that could serve as test bed for local companies, as an incubator, and to attract scientists and companies from around the world. Developing a domestic desalination market faces regulatory hurdles similar to aquaculture and other waterfront and offshore industries.

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<sup>7</sup>Global Water Intelligence [www.globalwaterintel.com](http://www.globalwaterintel.com)

## Maritime Robotics Sector

San Diego has a long history in underwater vehicles and maritime robotics, initially driven by the Navy's needs. Over the decades, the major Navy lab in San Diego (SPAWAR Systems Center Pacific) developed ten manned underwater vehicles and nearly two dozen unmanned vehicles. Multiple companies have added to this experience base by creating various kinds of UUVs (Unmanned Underwater Vehicles) and/or servicing those of the Navy. It has become clear over the last decade across two wars that aerial and terrestrial robotics have become an essential and growing part of the DoD's future. Maritime robotics above and below water are likewise destined to follow a similar path.<sup>8</sup>

In addition, many non-military and civilian uses are developing, including heavy usage in aquaculture, ocean observation, and offshore energy. San Diego is one of the leading robotics centers in the U.S. and the world and is in a unique position to be able to integrate robotics across domains (in the air, on the ground, on the water and underwater) for both defense and civilian uses. As was indicated above, one company saw an opportunity for the creation of a West Coast depot maintenance facility in San Diego for unmanned vehicles. A national Maritime Robotics Center of Excellence could focus the region's efforts and broaden awareness as it could serve as a national test bed.

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<sup>8</sup> According to separate reports by Douglas-Westwood, the worldwide ROV market is expected to double from 2010 to 2014 to \$3.4 billion while the AUV market is expected to triple in the decade from 2010 to 2019. (2010) [www.douglas-westwood.com](http://www.douglas-westwood.com)

## Policy Recommendations

The results of the project suggest a number of policy issues and recommendations. Many of them are not new. Some are already being pursued in one form or another today. Others have been proposed in the past, but were not adopted for various reasons. Whatever the history, emergence of the following issues and recommendations in the interviews and policy discussions suggest that the associated suite of policies should be reconsidered.

### Workforce

The issue of finding qualified talent with maritime knowledge and experience suggests exploration of creative alternatives. Examples of possible strategies include:

1. Maritime-specific modules inserted into existing courses
2. Specialized elective courses that focus on maritime-related topics within a variety of courses of study
3. Sponsored after-school activities
4. Funded maritime internships
5. Work-study programs

TMA is in the process of organizing sector working groups. Among other tasks, these working groups are expected to identify workforce needs. Once needs are identified, the working groups will be able to work with secondary vocational programs, community colleges, and four-year and graduate institutions to help adopt or design curricula and programs.

Both the fishing industry and the shipyards identified needs that fall in the general responsibility of the SDWP and fit the training mandate of high school career centers and community colleges. Representatives in both industries expressed a willingness to collaborate in pursuit of this objective. This activity could also potentially support the desire for more maritime-specific exposure for production and service staff recruits.

1. Fishing, in particular, is facing a significant retirement profile and will need new entrants solely to maintain current employment levels, much less grow. The old apprenticeship model is no longer providing the required number of replacement workers.
2. New training and education must reflect the fact that boats now have extensive new technologies and the business of fishing has changed considerably.
3. Opportunity may exist for the creation of unique maritime tracks in career programs among high schools and community colleges. Some of the skills needed for individuals pursuing a fishing career overlap with those required by shipyard workers, especially in mechanics and electronics.

There was some interest in exploring whether SDWP, SDREDC, and the TMA could help support targeted recruiting for occupations and skills needed by firms in the cluster.

### **Business Attraction and Promotion**

Most firms agreed that more involvement in the local maritime community – and in The Maritime Alliance cluster activities – would be better, but with so many firms having so few local customers, the interviewees had a difficult time justifying the time and money for local involvement in events. In part, this reflects the external focus of the companies. But it also reflects the relatively low level of participation in regional networking activities focused on facilitating near-sourcing opportunities, hosted by TMA, SDWP, and SDREDC. General agreement emerged concerning the need for the SDREDC to focus on attracting and promoting high wage, high value-added, capital and R&D intensive firms and operations. Five focus areas emerged for initial priority attention.

1. Target offshore energy, and potentially offshore minerals extraction, as a priority cluster strategy effort. The range of companies in the San Diego region with deep expertise and technologies focused on operations in hostile ocean environments face an exciting array of opportunities. Although they serve similar customer bases, most are insular, niche firms and have not seen themselves as part of a San

Diego regional cluster. Because of the significant potential, offshore energy and minerals may deserve to be one of the primary initiative areas over the next 12-18 months.

- ▶ TMA identification of “ocean energy and minerals” as a key sector is a great first step. Now, it is time to begin a serious effort to engage the members of this and related cluster groups to identify shorter- and longer-term initiatives and strategies. The goal is twofold: enhance their success and reinforce their ties to San Diego.
- ▶ Firms in this sub-cluster collectively possess extensive contacts and business relationships across the full spectrum of the offshore energy and minerals value chain—an incredible competitive asset, given the aforementioned importance of the sector to the full maritime space.
- ▶ The most immediate challenge is to begin the process of persuading the firms that they are part of a larger, regional community that can provide real benefits to their own bottom line. Some initiatives that appear to have traction include:
- ▶ Conduct meetings among local firms in the broader sectors to share information on their technologies and strengths and the specific challenges facing their offshore energy and materials customers.
- ▶ Host specific events that highlight major buyers in the offshore energy and minerals value chain. Such events would focus on both current needs and the unique problems they are trying to solve (e.g., their R&D challenges).
- ▶ Regional brokering of offshore energy and materials opportunities, ranging from identification of opportunities that one or more of the local firms might pursue to assembling teams to pursue larger or more complex opportunities than any local firm could pursue individually.

2. Launch a focused effort to take advantage of (and protect San Diego from) changing DoD strategy and restructuring.

- ▶ With the looming drawdown and the shifting Navy strategic focus on the Pacific, many activities and commands will undergo significant restructuring in coming years. It is not wise to wait for the next BRAC before launching a serious military-based economic development strategy.
  - ▶ Many firms were interested in assistance with Navy procurement. They would like to see focused programs that explore concrete procurement opportunities and identify key problems and challenges that the Navy is trying to solve. Others were particularly interested in help identifying collaborators and partners for major opportunities.
3. Strengthen organizational participation in the existing TMA Seafood (Aquaculture and Fishing) Working Group that brings together the fishing, processing, aquaculture and other related interests to determine if the strong mutual interests identified can be leveraged into a seafood strategy for the region or the state.
- ▶ It is important to maintain the range of both tactical and strategic issues associated with fishing and aquaculture. The linkages and synergy between them is not always well understood or articulated.
  - ▶ The fishing and seafood processing industries would be the foundation upon which to build an aquaculture strategy. Moreover, fishing and processing are good candidates for entry-level workers with the right skills.
4. Aggressively promote shipbuilding, repair, and refit. Shipbuilding, repair, and refit, especially in the smaller yards, emerged as a relatively robust local industry. Small yards have significantly enhanced capacity in recent years, especially their capability to support the super and mega yachts and larger commercial craft. The yards interviewed have seen significant expansion of naval work as well. The existence of these shipyards can also be marketed to attract newer entrants in ocean energy such as offshore wind energy and OTEC manufacturing, and designers of new boats such as small, fast



amphibious craft for special operations and other types of fast boats that need innovative builders.

5. Logistics was another area identified for which more leadership might be necessary in any effort to enhance seaborne trade and the associated land-based, logistics infrastructure.

## Regulation and Permitting

Regulation and permitting are of serious concern among many respondents. Details varied by industry, and many of the concerns were with California and federal regulations. A broad consensus emerged that the regional organizations were not aggressive enough in helping to deal with local regulatory concerns or in providing advocacy support in state and federal arenas. Specific recommendations included:

- ▶ Building permits are seen as onerous to acquire and firms believe the workforce and economic development entities should be more aggressive in facilitating business expansion.
- ▶ Many firms would like to see a more focused and coordinated community-wide effort to improve local and regional planning and permitting to protect the working waterfront.
- ▶ Many supported strong local advocacy in support of reducing the state burden on maritime activity, such as:
  - Easing commercial regulation on surveying and mapping activity and on recreational yachts over 300 tons
  - Efforts to harmonize California ballast water regulations with those promulgated by the International Maritime Organization, at least until a common suite of U.S. regulations are issued.
- ▶ Yards claim that they face overlapping and sometimes conflicting regulations and oversight from multiple agencies and that San Diego is worse than the rest of California. This claim should be assessed, and, if true, given careful consideration and attention.

## Infrastructure

The single most mentioned infrastructure-related topic was “protecting the working waterfront.” Although this has been a responsibility primarily of the Port and Port Tenants, strong concerns were expressed that the various maritime organizations were not doing enough collectively.

- ▶ Creation of joint-use facilities. Several firms expressed strong interest in the creation of world-class testing facilities that firms could access. Other firms supported the creation of incubator space for young firms, which also included access to shared equipment and facilities (and maybe ocean access as well).
- ▶ An attractive, lower-cost alternative (though not mutually exclusive) is the creation of a network of existing specialized facilities, equipment, and other assets that could be made available to smaller firms (for a fee). The concept was that TMA and/or SDREDC become the intermediary for such a network of assets through a web of memoranda of understanding (MOU) and access agreements.
- ▶ A related proposal was to create a core marine biology facility for joint use (similar to an existing North Carolina initiative). The region has Scripps, NOAA, the Coastal Waters Laboratory and other facilities, but they are not widely known or structured for joint commercial use.
- ▶ Union leadership suggested passage of a transportation bond issue to facilitate expansion of the logistics cluster.
- ▶ Maintenance dredging was noted as potentially becoming a major issue—vital to the working waterfront, but hamstrung by current environmental and budgetary issues. The realignment of Navy assets to the Pacific can be leveraged to help support required maintenance dredging.

## Support Services

**Networking:** Networking is seen as important, but so many firms view themselves as unique, niche players that new approaches need to be explored to attract participation and discovery of common interests. This is intensified by the number of firms with customers outside the region.

**Collaboration and partnering on big opportunities:** many of the smaller firms expressed a potential interest in TMA or SDREDC taking a much stronger role to help identify major opportunities and facilitate the assembly of teams to pursue these opportunities. There was also an interest in help to identify and pursue funding opportunities from nontraditional sources.

**Navy assistance:** The Navy is understandably seen as an important but complex customer. Many of the firms have found it difficult to both identify opportunities with the Navy and to effectively pursue them. They are seeking structured consistent help in attacking Navy opportunities, as well as defense opportunities in general. At a minimum, they would like to see focused programs which explore concrete procurement opportunities and identify key problems and challenges that the Navy or major prime contractors to the Navy and Department of Defense are trying to solve.

**Large firm assistance:** This is essentially the same support request as with the Navy, but in a more general context. Smaller firms would like to see programs designed to introduce the large firms' concrete interests to the smaller firms, along with how to sell to them or partner with them on bids that require small business participation. Programs for the Navy and large firms have been offered by TMA and the SDREDC, but participation and support have been relatively weak. Firms indicate that they want highly focused and concrete programs. The first step should be the development of a detailed diagnostic of the connections and gaps between firm desires and the capabilities of TMA and SDREDC.

**Facilitation and brokering:** Some would like to see TMA and SDREDC assume a more explicit role in helping to find large company mentors and partners and to pursue major market opportunities. Firms were clear that general

small business initiatives are unnecessary and felt that too much time is devoted to these types of initiatives.

**Common interests:** Despite the **Blue Tech** cluster composition of a variety of niche firms, there is considerable overlap of intellectual property and expertise, especially with regard to operating in a hostile marine environment (both surface and subsurface). Some interest was expressed in getting firms together to explore these common strengths and challenges and identify opportunities. Offshore energy and defense emerged as the two areas with the strongest potential opportunities.

**Joint marketing:** Some firms expressed an interest in exploring shared-cost opportunities by jointly participating in targeted events and trade shows, especially offshore where costs can be very high. However, history has demonstrated that joint marketing is difficult to organize, unless there is very strong mutual interest in a specific event, significant cost reduction compared to going alone, and other collateral benefits from collaboration.

**Joint R&D/Technical collaboration:** Some interest was expressed in the idea of creating a complement to the existing array of world-class research assets in the region, such as a Marine Center of Excellence or Marine Technology Center with cooperation from companies, postsecondary institutions, and research centers, but with a mission to support commercialization, instead of pure research.

**Enhanced collaboration among related organizations:** Firms noted that there are many maritime-related organizations in the San Diego region. This leads to competing events and diffuse programming. Many firms expressed an interest in seeing the various organizations working more closely together.

**Think Big:** Several respondents communicated an impression that the San Diego community does not think big enough in the maritime space. The recommendation was clearly to come up with a big idea and make it happen (such as the Maritime Center of Excellence).

**Creative Collaboration:** The challenge that maritime firms' uniqueness poses for collaboration requires creative planning. One way of overcoming these challenges is to connect maritime initiatives to existing initiatives or strategies, where possible, which then provides a framework for action. For example, a new initiative for California offers potential in this regard.

On July 2, 2012, The California Stewardship Network and California Forward, released the first-ever *California Economic Summit Action Plan*. Seven priority actions were recommended in five signature initiative areas:

1. Smart Regulations: California Environmental Quality Act
2. Smart Regulations: Streamlining Regulations
3. Smart Workforce
4. Smart Innovation
5. Smart Capital
6. Smart Infrastructure: Financing
7. Smart Infrastructure: Water

These priorities are not difficult to connect to the needs and interests of San Diego's maritime community, and could be leveraged to create group action among the industry's employers.

- ▶ At a basic level, the plan focuses on economic clusters as a core policy strategy.
- ▶ While too exhaustive to list here, the detailed elements of the Smart Innovation, Smart Workforce, and Smart Infrastructure initiatives offer a range of potentially useful building blocks to help implement various recommendations discussed in this report.
- ▶ Although maritime regulation was not explicitly addressed, the specific Smart Regulation recommendations are a great platform to begin addressing the regulatory barriers to maritime industry growth discussed by employers.

While the plan is new, San Diego should immediately designate a responsible party to monitor any action that results in Sacramento (and to support any elements beneficial to the Maritime Industry, if possible). In addition, the region should begin thinking about strategies to connect the Plan to the larger policy recommendations suggested by this report.

## Appendix A – Industry Employment Estimates

Industry Employment 2011 estimates & 2020 projection, Maritime and Non-Maritimes						
NAICS	Industry	Functional Category	2011 Maritime Emp	2011 Non-Maritime Emp	2020 Maritime Emp	2020 Non-Maritime Emp
111998	All Other Misc. Crop Farming	Core Other	63	254	59	239
112511	Finfish Farming & Fish Hatcheries	Core Only	2	0	2	0
112512	Shellfish Farming	Core Only	0	0	N/A	N/A
112519	Other Animal Aquaculture	Core Only	29	0	28	0
114111	Finfish Fishing	Core Only	66	0	57	0
114112	Shellfish Fishing	Core Only	1	0	1	0
114119	Other Marine Fishing	Core Only	0	0	N/A	N/A
211111	Crude Petroleum & Natural Gas Extraction	Core Other	5	19	5	22
213111	Drilling Oil & Gas Wells	Core Other	5	21	5	21
213112	Support Activities For Oil & Gas Operations	Core Other	13	55	13	54
221310	Water Supply & Irrigation Systems	Core Other	525	1228	637	1489
236210	Industrial Building Construction	Core Other	364	58	446	71
237110	Water & Sewer System Construction	Core Other	59	1096	72	1343
237120	Oil & Gas Pipeline Construction	Core Other	115	465	141	570
237130	Power & Communication System Construction	Tech	115	464	141	569
237990	Other Heavy Construction	Core Other	158	638	193	782
238110	Poured Concrete Structure Contrs	Core Other	225	908	275	1113
238120	Steel & Precast Concrete Contrs	Core Other	169	683	207	837
238130	Framing Contrs	Core Other	166	669	203	820
238190	Other Building Exterior Contrs	Core Other	69	279	85	342
238210	Electrical Contrs	Core Other	593	7502	726	9190
238220	Plumbing & HVAC Contrs	Core Other	1935	5274	2370	6460
238290	Other Building Equip Contrs	Core Other	109	442	134	541
238320	Paint & Wall Covering Contrs	Core Other	538	2173	659	2662
238350	Finish Carpentry Contrs	Core Other	228	924	280	1131
238910	Site Preparation Contrs	Core Other	381	1539	466	1885
238990	All Other Specialty Trade Contrs	Core Other	926	2330	1135	2854
311710	Seafood Product Preparation And Packaging	Tech	6	0	13	0
311942	Spice And Extract Manufacturing	Core Other	0	8	N/A	8
315190	Other Apparel Knitting Mills	Core Other	4	33	2	17
321992	Prefabricated Wood Blding Mfg.	Core Other	1	5	1	5
321999	Misc. Wood Prod Mfg.	Core Other	7	27	8	31



323113	Commercial Screen Printing	Tech	3	764	3	713
324110	Petroleum Refineries	Tech	7	28	6	25
325412	Pharmaceutical Preparation Mfg.	Tech	180	729	183	740
326199	All Other Plastics Prod Mfg.	Core Other	307	1242	358	1447
326299	All Other Rubber Prod Mfg.	Core Other	9	37	9	35
331222	Steel Wire Drawing	Tech	85	0	90	0
331491	Nonferrous Metal (Except Copper And Aluminum) Rolling, Drawing, And Extruding	Tech	14	0	13	0
331529	Other Nonferrous Metal Foundries (Except Die-Casting)	Core Other	0	0	N/A	N/A
332211	Cutler And Flatware (Except Precious) Manufacturing	Core Other	0	0	N/A	N/A
332312	Fabricated Structural Metal Mfg.	Core Other	73	407	88	492
332420	Metal Tank, Heavy Gauge, Mfg.	Core Other	7	26	7	28
332439	Other Metal Container Mfg.	Core Other	7	30	8	31
332510	Hardware Mfg.	Core Other	4	17	4	16
332999	All Other Miscellaneous Fabricated Metal Product Manufacturing	Tech	3	408	3	443
333415	Ac, Refrigeration, & Forced Air Heating	Core Other	34	139	33	134
333911	Pump And Pumping Equipment Manufacturing	Tech	35	48	34	47
333923	Overhead Cranes, Hoists, & Monorail Systems	Core Other	0	1	0	1
333999	All Other Miscellaneous General Purpose Machinery Manufacturing	Tech	7	432	7	422
334220	Broadcast & Wireless Communications Equip	Tech	1004	3155	777	2439
334290	Other Communications Equipment Manufacturing	Tech	30	377	23	291
334310	Audio And Video Equipment Manufacturing	Tech	302	1933	279	1789
334413	Semiconductor And Related Device Manufacturing	Tech	62	2407	57	2232
334419	Other Electronic Component Manufacturing	Tech	85	898	79	833
334511	Search, Detection, & Navigation Instruments	Tech	1973	3217	1802	2938
334513	Instruments And Related Products Manufacturing For Measuring, Displaying, And Controlling Industrial Process Variables	Tech	175	1392	160	1271
334519	Other Measuring And Controlling Device Manufacturing	Tech	35	460	32	420
335129	Other Lighting Equipment Manufacturing	Tech	110	0	102	0
335210	Small Electrical Appliance Mfg.	Tech	7	4	7	4

335312	Motor And Generator Manufacturing	Tech	43	214	38	189
335314	Relay And Industrial Control Manufacturing	Tech	15	30	13	26
336214	Travel Trailer & Camper Mfg.	Core Other	2	9	2	9
336320	Motor Vehicle Electrical And Electronic Equipment Manufacturing	Core Other	0	73	0	70
336360	Motor Vehicle Seating & Interior Trim Mfg.	Core Other	13	51	12	49
336611	Ship Building & Repairing	Core Only	6127	0	6226	0
336612	Boat Building	Core Only	231	0	235	0
339112	Surgical And Medical Instrument Manufacturing	Tech	90	2424	91	2460
339920	Sporting & Athletic Goods Mfg.	Core Other	480	1940	397	1605
339992	Musical Instrument Manufacturing	Tech	35	507	29	419
339999	All Other Misc. Mfg.	Core Other	283	297	234	245
423110	Motor Vehicle Merchant Whols	Core Other	200	227	221	251
423410	Photographic Equipment And Supplies Merchant Wholesalers	Tech	36	83	40	92
423490	Other Professional Equip Merchant Whols	Core Other	72	123	80	136
423610	Electrical Apparatus And Equipment, Wiring Supplies, And Related Equipment Merchant Wholesalers	Tech	16	856	18	946
423690	Other Electronic Parts Merchant Whols	Tech	583	1693	644	1871
423720	Plumbing Equip Merchant Whols	Core Other	282	1139	311	1259
423830	Industrial Machinery Merchant Whols	Core Other	524	705	579	779
423840	Industrial Supplies Merchant Wholesalers	Tech	20	409	22	452
423860	Other Transportation Goods Merchant Whols	Core Other	81	46	90	51
423910	Sporting Goods Merchant Whols	Core Other	421	1417	465	1566
423990	All Other Durable Goods Merchant Whols	Core Other	153	306	169	338
424210	Druggists' Goods Merchant Whols	Tech	414	1673	457	1849
424320	Men's & Boy's Clothing Merchant Whols	Core Other	70	285	78	314
424460	Fish & Seafood Merchant Whols	Core Only	313	0	346	0
424690	Other Chemical And Allied Products Merchant Wholesalers	Tech	14	775	15	856
424950	Paint & Supplies Merchant Whols	Core Other	36	144	39	159
424990	Other Nondurable Goods Merchant Whols	Core Other	267	1081	295	1194
425120	Wholesale Trade Agents & Brokers	Core Other	919	3715	1016	4105
441210	Recreational Vehicle Dealers	Core Other	69	280	76	305

441222	Boat Dealers	Core Only	268	0	293	0
441310	Automotive Parts & Accessories Stores	Core Other	566	2261	617	2469
444190	Other Building Material Dealers	Core Other	349	1413	382	1542
445110	Supermarkets And Other Grocery (Except Convenience) Stores	Core Other	6	22800	7	24894
445220	Fish And Seafood Markets	Core Only	82	0	90	0
445299	All Other Specialty Food Stores	Core Other	122	493	133	538
447190	Other Gasoline Stations	Core Other	160	646	175	705
448110	Men's Clothing Stores	Core Other	86	347	94	379
451110	Sporting Goods Stores	Core Other	809	2665	884	2909
453998	Store Retailers Not Specified Elsewhere	Core Other	237	959	259	1047
483111	Deep Sea Freight Transportation <sup>9</sup>	Core Only	0	0	N/A	N/A
483112	Deep Sea Passenger Transportation <sup>9</sup>	Core Only	0	0	N/A	N/A
483113	Coastal & Great Lakes Freight Transportation <sup>9</sup>	Core Only	0	0	N/A	N/A
483114	Coastal & Great Lakes Passenger Trnsprtn <sup>9</sup>	Core Only	0	0	N/A	N/A
483211	Inland Water Freight Transportation <sup>9</sup>	Core Only	0	0	N/A	N/A
483212	Inland Water Passenger Transportation <sup>9</sup>	Core Only	0	0	N/A	N/A
484230	Other Specialized Trucking, Long-Distance	Core Other	55	220	65	265
487210	Scenic & Sightseeing Transportation, Water	Core Only	583	0	674	0
488310	Port & Harbor Operations	Core Only	0	0	N/A	N/A
488320	Marine Cargo Handling	Core Only	0	0	N/A	N/A
488330	Navigational Svcs To Shipping	Core Only	66	0	76	0
488390	Other Support Activities-Water Transportation	Core Only	126	0	146	0
488510	Freight Transportation Arrangement	Tech	250	1012	289	1170
488991	Packing & Crating	Core Other	21	86	25	99
492210	Local Messengers & Local Delivery	Core Other	88	357	107	432
512110	Motion Picture & Video Production	Tech	70	282	66	267
517210	Wireless Telecommunications Carriers (Except Satellite)	Tech	0	2506	0	2681
517919	All Other Telecommunications	Tech	10	309	11	331
518000	Data Processing, Hosting, And Related Services	Tech	75	606	80	647
522291	Consumer Lending	Core Other	190	769	197	797

<sup>9</sup> The data above are the result of industry surveys conducted by the Bureau of Labor Statistics and, as such, are subject to the same errors as any survey. Other research suggests higher employment in Port and Maritime Operations' industries. Please see **XXXX (Unsure of Report Name, but must be cited here)**.

523930	Investment Advice	Core Other	6	1598	7	1922
523999	Miscellaneous Financial Investment Activities	Core Other	7	20	8	24
524126	Direct Property & Casualty Insurers	Core Other	891	3601	916	3703
531390	Other Activities Related To Real Estate	Core Other	247	999	267	1080
532120	Truck, Trailer, & RV Rental & Leasing	Core Other	79	320	84	340
532292	Recreational Goods Rental	Core Other	0	134	0	155
532411	Commercial, Air, Rail, Water, And Transportation Equipment Rental And Leasing	Core Other	0	74	0	95
541320	Landscape Architectural Services	Tech	14	969	17	1182
541330	Engineering Svcs	Tech	3228	9482	3937	11564
541360	Geophysical Surveying & Mapping Svcs	Tech	23	92	28	112
541370	Other Surveying & Mapping Svcs	Tech	21	167	25	204
541380	Testing Laboratories	Tech	3689	3867	4499	4716
541611	Administrative Management And General Management Consulting Services	Core Other	37	2867	54	4188
541612	Human Resources Consulting Services	Core Other	15	755	22	1103
541613	Marketing Consulting Services	Core Other	35	1420	51	2074
541614	Process, Physical Distribution, And Logistics Consulting Services	Tech	25	1370	37	2001
541618	Other Management Consulting Svcs	Tech	1610	2	2351	3
541711	Physical, Engineering, & Biological Research	Tech	100	9504	110	10472
541712	Research And Development In The Physical, Engineering, And Life Sciences (Except BioTechnology)	Tech	3376	15860	3720	17476
541910	Marketing Research And Public Opinion Polling	Core Other	156	1291	197	1627
541921	Photographic Studios, Portrait	Core Other	115	466	145	587
541922	Commercial Photography	Tech	6	83	8	105
541990	All Other Professional, Scientific, And Technical Services	Core Other	106	1589	134	2002
551111	Offices Of Bank Holding Companies	Core Other	14	5	15	5
561110	Office Administrative Svcs	Core Other	1157	4650	1372	5517
561310	Employment Placement Agencies	Core Other	120	3845	142	4551
561499	All Other Business Support Svcs	Core Other	113	151	130	174
561520	Tour Operators	Core Other	40	160	46	184
561720	Janitorial Services	Core Other	30	7058	34	7941

562998	Misc. Waste Management Svcs	Core Other	2	10	3	11
611200	Junior Colleges	Tech	3	10745	4	13252
611300	Colleges, Universities, And Professional Schools	Tech	170	25324	210	31233
611519	Other Technical And Trade Schools	Core Other	225	907	275	1112
611620	Sports & Recreation Instruction	Core Other	161	653	198	800
611710	Educational Support Services	Tech	14	567	17	695
621511	Medical Laboratories	Tech	435	1756	565	2285
622110	General Medical And Surgical Hospitals	Tech	150	32028	173	36995
712110	Museums	Tech	150	877	173	1009
712190	Nature Parks & Other Similar Institutions	Core Other	115	467	133	537
713930	Marinas	Core Only	227	0	258	0
713990	All Other Amusement & Recreation Industries	Core Other	307	1242	349	1412
722410	Drinking Places (Alcoholic Beverages)	Tech	26	3622	28	3893
811112	Automotive Exhaust System Repair	Core Other	3	67	4	81
811121	Automotive Body & Interior Repair	Core Other	399	1615	481	1944
811219	Other Electronic Equip Repair	Core Other	181	734	185	748
811310	Commercial Machinery Repair & Maintenance	Core Other	141	570	152	615
811490	Other Household Goods Repair & Maintenance	Core Other	184	299	174	282
813319	Other Social Advocacy Organizations	Core Other	9	840	11	1044
813910	Business Associations	Core Other	150	636	161	683
926120	Regulation Of Transportation Programs	Core Other	0	1788	0	1553

## Appendix B – Maritime Occupation Employment Data

Maritime Employment Levels and Projections for Occupations						
SOC	Occupation	2011 Emp.	2020 Emp.	2011-20 Growth & Openings	Short-term Growth & Openings (from survey)	San Diego MSA Avg. Annual Wage
11-1011	Chief Executives	114	117	27	0	\$192,610
11-1021	General and Operations Managers	839	884	174	6	\$128,880
11-2011	Advertising and Promotions Managers	4	8	4	N/A	\$110,130
11-2021	Marketing Managers	103	116	37	0	\$130,840
11-2022	Sales Managers	139	150	45	7	\$115,990
11-2031	Public Relations and Fundraising Managers	11	19	11	N/A	\$102,940
11-3011	Administrative Services Managers	85	99	31	-3	\$85,040
11-3021	Computer and Information Systems Managers	123	137	29	N/A	\$134,410
11-3031	Financial Managers	169	186	43	N/A	\$126,980
11-3051	Industrial Production Managers	115	118	25	N/A	\$100,510
11-3061	Purchasing Managers	59	52	8	N/A	\$112,700
11-3071	Transportation, Storage, and Distribution Managers	31	33	8	N/A	\$92,320
11-3111	Compensation and Benefits Managers	10	12	4	N/A	\$104,570
11-3121	Human Resources Managers	21	23	6	N/A	\$117,520
11-3131	Training and Development Managers	10	12	4	N/A	\$105,870
11-9021	Construction Managers	119	145	31	1	\$101,130
11-9033	Education Administrators, Postsecondary	11	14	5	N/A	\$96,770
11-9039	Education Administrators, All Other	6	8	3	N/A	\$91,650
11-9041	Architectural and Engineering Managers	260	262	44	2	\$140,610
11-9051	Food Service Managers	8	9	3	N/A	\$58,050
11-9081	Lodging Managers	1	2	1	N/A	\$55,620
11-9111	Medical and Health Services Managers	29	35	12	N/A	\$114,470
11-9121	Natural Sciences Managers	115	132	74	N/A	\$170,090
11-9141	Property, Real Estate, and Community Association Managers	34	46	18	N/A	\$63,220
11-9151	Social and Community Service Managers	3	5	3	N/A	\$64,430
11-9199	Managers, All Other	157	176	48	N/A	\$118,330
13-1021	Buyers and Purchasing Agents, Farm Products	3	3	1	N/A	\$59,500
13-1022	Wholesale and Retail Buyers, Except Farm Products	46	50	13	N/A	\$63,270
13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	210	215	51	0	\$67,880

13-1031	Claims Adjusters, Examiners, and Investigators	154	160	39	N/A	\$58,950
13-1032	Insurance Appraisers, Auto Damage	10	9	2	N/A	\$59,760
13-1041	Compliance Officers	70	89	27	N/A	\$74,410
13-1051	Cost Estimators	161	204	68	0	\$67,370
13-1078	Human Resources, Training, and Labor Relations Specialists, All Other	114	129	31	N/A	\$64,930
13-1081	Logisticians	66	91	35	N/A	\$80,470
13-1111	Management Analysts	408	545	192	N/A	\$80,750
13-1121	Meeting, Convention, and Event Planners	11	30	21	N/A	\$50,060
13-1141	Compensation, Benefits, and Job Analysis Specialists	41	45	10	N/A	\$62,500
13-1151	Training and Development Specialists	65	96	41	N/A	\$63,660
13-1161	Market Research Analysts and Marketing Specialists	163	235	108	N/A	\$65,650
13-1199	Business Operations Specialists, All Other	386	470	146	N/A	\$70,500
13-2011	Accountants and Auditors	358	419	125	0	\$74,370
13-2021	Appraisers and Assessors of Real Estate	13	13	2	N/A	\$72,820
13-2031	Budget Analysts	17	18	4	N/A	\$75,700
13-2041	Credit Analysts	8	9	3	N/A	\$68,280
13-2051	Financial Analysts	83	90	21	N/A	\$91,500
13-2052	Personal Financial Advisors	11	14	5	N/A	\$78,860
13-2053	Insurance Underwriters	76	86	30	N/A	\$66,400
13-2061	Financial Examiners	2	2	1	N/A	\$91,960
13-2071	Credit Counselors	7	8	2	N/A	\$45,600
13-2072	Loan Officers	42	48	15	N/A	\$66,930
13-2099	Financial Specialists, All Other	19	22	6	N/A	\$66,540
15-1111	Computer and Information Research Scientists	24	26	6	N/A	\$92,890
15-1121	Computer Systems Analysts	173	192	46	N/A	\$86,790
15-1131	Computer Programmers	100	104	23	N/A	\$76,190
15-1132	Software Developers, Applications	244	257	34	N/A	\$99,540
15-1133	Software Developers, Systems Software	334	373	68	N/A	\$103,290
15-1141	Database Administrators	42	55	19	N/A	\$78,840
15-1142	Network and Computer Systems Administrators	132	171	58	N/A	\$77,120
15-1150	Computer Support Specialists	172	192	58	N/A	\$50,370
15-1179	Information Security Analysts, Web Developers, and Computer Network Architects	98	107	21	N/A	\$90,560
15-1799	Computer Occupations, All Other	47	52	13	N/A	\$86,790
15-2011	Actuaries	10	13	8	N/A	\$98,710
15-2021	Mathematicians	3	4	2	N/A	\$95,120
15-2031	Operations Research Analysts	30	36	13	N/A	\$90,140
15-2041	Statisticians	21	24	13	N/A	\$108,520



17-1011	Architects, Except Landscape and Naval	5	6	2	5	\$90,280
17-1021	Cartographers and Photogrammetrists	2	3	1	N/A	\$57,290
17-1022	Surveyors	5	7	2	4	\$80,550
17-2011	Aerospace Engineers	99	111	30	-1	\$94,990
17-2031	Biomedical Engineers	27	48	26	N/A	\$96,150
17-2041	Chemical Engineers	36	44	18	N/A	\$86,490
17-2051	Civil Engineers	63	76	23	31	\$86,270
17-2061	Computer Hardware Engineers	116	117	24	5	\$102,210
17-2071	Electrical Engineers	240	240	47	11	\$99,270
17-2072	Electronics Engineers, Except Computer	196	195	38	N/A	\$102,200
17-2081	Environmental Engineers	55	70	25	N/A	\$79,600
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	30	33	7	N/A	\$87,860
17-2112	Industrial Engineers	307	312	60	N/A	\$82,850
17-2121	Marine Engineers and Naval Architects	32	33	7	0	\$78,140
17-2131	Materials Engineers	19	19	4	N/A	\$95,810
17-2141	Mechanical Engineers	503	550	180	6	\$88,790
17-2161	Nuclear Engineers	31	38	13	N/A	\$110,350
17-2199	Engineers, All Other	148	153	32	N/A	\$99,300
17-3011	Architectural and Civil Drafters	8	9	2	1	\$55,820
17-3012	Electrical and Electronics Drafters	37	36	5	N/A	\$53,610
17-3013	Mechanical Drafters	223	220	33	0	\$53,960
17-3019	Drafters, All Other	7	7	1	N/A	\$48,270
17-3021	Aerospace Engineering and Operations Technicians	12	12	2	N/A	\$62,370
17-3022	Civil Engineering Technicians	62	71	19	N/A	\$61,090
17-3023	Electrical and Electronics Engineering Technicians	269	267	41	17	\$61,940
17-3024	Electro-Mechanical Technicians	29	26	2	N/A	\$57,730
17-3025	Environmental Engineering Technicians	53	66	21	N/A	\$59,450
17-3026	Industrial Engineering Technicians	87	89	16	N/A	\$51,020
17-3027	Mechanical Engineering Technicians	121	125	24	N/A	\$48,180
17-3029	Engineering Technicians, Except Drafters, All Other	101	108	23	N/A	\$63,800
17-3031	Surveying and Mapping Technicians	6	8	3	1	\$59,270
19-1012	Food Scientists and Technologists	18	21	9	N/A	\$58,370
19-1013	Soil and Plant Scientists	29	33	14	N/A	\$76,050
19-1021	Biochemists and Biophysicists	90	119	46	N/A	\$96,530
19-1022	Microbiologists	43	52	17	0	\$63,170
19-1023	Zoologists and Wildlife Biologists	14	16	5	N/A	\$67,100
19-1029	Biological Scientists, All Other	32	36	10	N/A	\$73,660
19-1031	Conservation Scientists	2	3	1	N/A	\$76,900
19-1041	Epidemiologists	4	4	1	N/A	\$117,010

19-1042	Medical Scientists, Except Epidemiologists	265	351	100	N/A	\$82,880
19-1099	Life Scientists, All Other	20	23	3	N/A	\$76,220
19-2012	Physicists	40	46	15	N/A	\$92,810
19-2021	Atmospheric and Space Scientists	7	8	1	N/A	\$90,700
19-2031	Chemists	345	383	130	N/A	\$87,540
19-2032	Materials Scientists	25	29	10	2	\$84,360
19-2041	Environmental Scientists and Specialists, Including Health	130	159	61	0	\$71,600
19-2042	Geoscientists, Except Hydrologists and Geographers	20	26	11	N/A	\$75,870
19-2043	Hydrologists	2	3	1	N/A	\$92,090
19-2099	Physical Scientists, All Other	44	51	19	N/A	\$105,010
19-3011	Economists	7	10	4	N/A	\$100,470
19-3022	Survey Researchers	12	16	7	N/A	\$45,810
19-3031	Clinical, Counseling, and School Psychologists	4	4	1	N/A	\$85,440
19-3051	Urban and Regional Planners	4	5	3	N/A	\$83,410
19-3091	Anthropologists and Archeologists	2	3	2	N/A	\$59,900
19-3099	Social Scientists and Related Workers, All Other	9	10	5	N/A	\$74,870
19-4011	Agricultural and Food Science Technicians	33	39	15	N/A	\$29,860
19-4021	Biological Technicians	216	240	84	150	\$46,870
19-4031	Chemical Technicians	338	431	132	N/A	\$56,800
19-4041	Geological and Petroleum Technicians	22	27	11	N/A	\$62,540
19-4061	Social Science Research Assistants	27	34	17	N/A	\$39,850
19-4091	Environmental Science and Protection Technicians, Including Health	108	130	59	N/A	\$46,130
19-4092	Forensic Science Technicians	5	6	3	N/A	\$65,680
19-4093	Forest and Conservation Technicians	4	5	2	N/A	\$39,290
19-4099	Life, Physical, and Social Science Technicians, All Other	139	159	68	N/A	\$53,300
21-1012	Educational, Guidance, School, and Vocational Counselors	6	8	3	N/A	\$58,500
21-1021	Child, Family, and School Social Workers	1	2	1	N/A	\$51,840
21-1022	Healthcare Social Workers	3	3	1	N/A	\$59,390
21-1029	Social Workers, All Other	2	3	1	N/A	\$60,310
21-1091	Health Educators	1	2	1	N/A	\$50,400
21-1093	Social and Human Service Assistants	3	4	1	N/A	\$30,950
21-1798	Community and Social Service Specialists, All Other	4	6	3	N/A	\$41,670
23-1011	Lawyers	34	43	15	N/A	\$144,140
23-2011	Paralegals and Legal Assistants	13	20	8	N/A	\$54,870
23-2093	Title Examiners, Abstractors, and Searchers	27	26	3	N/A	\$60,290
23-2099	Legal Support Workers, All Other	3	4	1	N/A	\$66,960

25-2011	Preschool Teachers, Except Special Education	1	2	1	N/A	\$31,680
25-3011	Adult Basic and Secondary Education and Literacy Teachers and Instructors	5	6	2	N/A	\$59,440
25-3021	Self-Enrichment Education Teachers	52	63	18	N/A	\$44,160
25-3999	Teachers and Instructors, All Other	41	52	16	N/A	\$50,400
25-4011	Archivists	2	3	1	N/A	\$52,830
25-4012	Curators	12	17	7	N/A	\$63,140
25-4013	Museum Technicians and Conservators	9	9	3	N/A	\$37,330
25-4021	Librarians	7	8	3	N/A	\$65,940
25-4031	Library Technicians	2	2	1	N/A	\$37,040
25-9031	Instructional Coordinators	13	17	6	N/A	\$68,540
25-9041	Teacher Assistants	12	15	5	N/A	\$28,530
25-9099	Education, Training, and Library Workers, All Other	5	6	2	N/A	\$32,400
27-1011	Art Directors	4	5	2	N/A	\$85,400
27-1012	Craft Artists	1	1	0	N/A	\$41,758
27-1013	Fine Artists, Including Painters, Sculptors, and Illustrators	4	5	2	N/A	\$29,330
27-1014	Multimedia Artists and Animators	1	1	0	N/A	\$69,230
27-1021	Commercial and Industrial Designers	36	40	13	N/A	\$59,730
27-1022	Fashion Designers	4	5	2	N/A	\$65,400
27-1023	Floral Designers	2	2	0	N/A	\$25,870
27-1024	Graphic Designers	52	64	25	N/A	\$51,560
27-1025	Interior Designers	1	1	0	N/A	\$53,310
27-1026	Merchandise Displayers and Window Trimmers	13	15	5	N/A	\$35,580
27-1027	Set and Exhibit Designers	3	3	1	N/A	\$42,980
27-2011	Actors	1	1	0	N/A	\$83,245
27-2012	Producers and Directors	2	3	2	N/A	\$81,040
27-2022	Coaches and Scouts	25	36	17	N/A	\$45,670
27-2031	Dancers	1	1	0	N/A	\$24,041
27-2032	Choreographers	5	7	3	N/A	\$42,530
27-2099	Entertainers and Performers, Sports and Related Workers, All Other	1	1	0	N/A	\$42,078
27-3031	Public Relations Specialists	49	96	58	N/A	\$58,970
27-3041	Editors	13	23	13	N/A	\$51,500
27-3042	Technical Writers	47	53	13	N/A	\$77,860
27-3043	Writers and Authors	6	10	5	N/A	\$50,150
27-3091	Interpreters and Translators	2	6	4	N/A	\$48,390
27-4011	Audio and Video Equipment Technicians	3	4	2	N/A	\$46,730
27-4021	Photographers	60	76	21	N/A	\$38,590
27-4031	Camera Operators, Television, Video, and Motion Picture	1	1	0	N/A	\$45,880
27-4032	Film and Video Editors	1	1	0	N/A	\$46,780

27-4099	Media and Communication Equipment Workers, All Other	1	1	0	N/A	\$75,140
29-1031	Dietitians and Nutritionists	1	1	0	N/A	\$60,950
29-1051	Pharmacists	9	11	3	N/A	\$119,940
29-1071	Physician Assistants	1	1	0	N/A	\$92,210
29-1111	Registered Nurses	90	111	34	N/A	\$84,900
29-1122	Occupational Therapists	1	1	0	N/A	\$74,900
29-1123	Physical Therapists	1	2	0	N/A	\$88,550
29-1124	Radiation Therapists	1	1	0	N/A	\$93,800
29-1126	Respiratory Therapists	3	3	1	N/A	\$63,870
29-1131	Veterinarians	1	1	0	N/A	\$82,150
29-1199	Health Diagnosing and Treating Practitioners, All Other	1	1	0	N/A	\$85,020
29-2011	Medical and Clinical Laboratory Technologists	74	93	31	N/A	\$69,060
29-2012	Medical and Clinical Laboratory Technicians	87	100	27	N/A	\$40,110
29-2031	Cardiovascular Technologists and Technicians	3	4	1	N/A	\$60,000
29-2032	Diagnostic Medical Sonographers	10	15	6	N/A	\$83,310
29-2033	Nuclear Medicine Technologists	3	4	1	N/A	\$81,760
29-2037	Radiologic Technologists and Technicians	50	67	24	N/A	\$65,990
29-2041	Emergency Medical Technicians and Paramedics	2	2	1	N/A	\$34,600
29-2052	Pharmacy Technicians	10	10	2	N/A	\$38,430
29-2055	Surgical Technologists	2	3	1	N/A	\$51,610
29-2056	Veterinary Technologists and Technicians	7	8	2	N/A	\$36,830
29-2061	Licensed Practical and Licensed Vocational Nurses	11	13	4	N/A	\$48,240
29-2071	Medical Records and Health Information Technicians	14	18	6	N/A	\$40,850
29-2091	Orthotists and Prosthetists	1	1	0	N/A	\$53,500
29-2799	Health Technologists and Technicians, All Other	8	9	3	N/A	\$44,370
29-9011	Occupational Health and Safety Specialists	24	28	11	N/A	\$79,310
29-9012	Occupational Health and Safety Technicians	2	3	1	N/A	\$61,500
29-9091	Athletic Trainers	1	1	0	N/A	\$47,390
29-9799	Healthcare Practitioners and Technical Workers, All Other	5	6	2	N/A	\$68,320
31-1011	Home Health Aides	2	2	1	N/A	\$23,340
31-1012	Nursing Aides, Orderlies, and Attendants	14	15	3	N/A	\$26,360
31-9011	Massage Therapists	1	1	0	N/A	\$34,020
31-9092	Medical Assistants	16	20	6	N/A	\$31,770
31-9093	Medical Equipment Preparers	6	7	2	N/A	\$28,200
31-9094	Medical Transcriptionists	8	9	3	N/A	\$43,630

31-9095	Pharmacy Aides	1	1	0	N/A	\$26,070
31-9096	Veterinary Assistants and Laboratory Animal Caretakers	11	16	6	N/A	\$27,740
31-9799	Healthcare Support Workers, All Other	63	78	23	N/A	\$37,770
33-1099	First-Line Supervisors of Protective Service Workers, All Other	4	6	3	N/A	\$48,960
33-2011	Firefighters	3	4	1	N/A	\$62,210
33-9021	Private Detectives and Investigators	2	2	1	N/A	\$75,510
33-9032	Security Guards	90	119	41	N/A	\$27,600
33-9099	Protective Service Workers, All Other	6	7	4	N/A	\$36,400
35-1011	Chefs and Head Cooks	4	4	1	N/A	\$54,380
35-1012	First-Line Supervisors of Food Preparation and Serving Workers	8	9	3	N/A	\$31,510
35-2011	Cooks, Fast Food	3	3	1	N/A	\$19,900
35-2012	Cooks, Institution and Cafeteria	3	3	1	N/A	\$28,040
35-2014	Cooks, Restaurant	11	14	5	N/A	\$25,410
35-2015	Cooks, Short Order	4	4	1	N/A	\$23,050
35-2019	Cooks, All Other	1	1	0	N/A	\$25,060
35-2021	Food Preparation Workers	23	26	10	N/A	\$20,460
35-3011	Bartenders	31	39	16	N/A	\$21,190
35-3021	Combined Food Preparation and Serving Workers, Including Fast Food	29	32	10	N/A	\$20,580
35-3022	Counter Attendants, Cafeteria, Food Concession, and Coffee Shop	13	15	10	N/A	\$21,030
35-3031	Waiters and Waitresses	41	48	24	N/A	\$19,620
35-3041	Food Servers, Nonrestaurant	3	4	1	N/A	\$22,820
35-9011	Dining Room and Cafeteria Attendants and Bartender Helpers	6	7	3	N/A	\$18,670
35-9021	Dishwashers	3	4	2	N/A	\$19,150
35-9031	Hosts and Hostesses, Restaurant, Lounge, and Coffee Shop	2	2	1	N/A	\$19,360
35-9099	Food Preparation and Serving Related Workers, All Other	1	1	0	N/A	\$20,430
37-1011	First-Line Supervisors of Housekeeping and Janitorial Workers	5	7	2	N/A	\$40,050
37-1012	First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers	2	4	2	N/A	\$46,980
37-2011	Janitors and Cleaners, Except Maids and Housekeeping Cleaners	157	189	57	4	\$26,690
37-2012	Maids and Housekeeping Cleaners	18	27	11	N/A	\$21,060
37-3011	Landscaping and Groundskeeping Workers	48	69	27	1	\$26,450
37-3012	Pesticide Handlers, Sprayers, and Applicators, Vegetation	2	3	1	N/A	\$30,740
39-1021	First-Line Supervisors of Personal Service Workers	7	9	3	N/A	\$39,830
39-2011	Animal Trainers	3	3	1	N/A	\$25,930
39-2021	Nonfarm Animal Caretakers	35	44	16	N/A	\$22,820

39-3031	Ushers, Lobby Attendants, and Ticket Takers	11	13	8	N/A	\$22,810
39-3091	Amusement and Recreation Attendants	25	33	20	N/A	\$20,470
39-5012	Hairdressers, Hairstylists, and Cosmetologists	2	2	1	N/A	\$25,030
39-6012	Concierges	1	3	2	N/A	\$27,810
39-7011	Tour Guides and Escorts	59	71	31	N/A	\$31,570
39-9011	Childcare Workers	2	3	1	N/A	\$24,180
39-9021	Personal Care Aides	3	5	2	N/A	\$21,450
39-9031	Fitness Trainers and Aerobics Instructors	5	7	2	N/A	\$40,360
39-9032	Recreation Workers	5	8	4	N/A	\$26,010
39-9041	Residential Advisors	1	2	1	N/A	\$29,860
39-9099	Personal Care and Service Workers, All Other	1	3	2	N/A	\$23,050
41-1011	First-Line Supervisors of Retail Sales Workers	231	250	63	N/A	\$44,100
41-1012	First-Line Supervisors of Non-Retail Sales Workers	103	114	33	0	\$71,330
41-2011	Cashiers	346	372	155	0	\$22,220
41-2021	Counter and Rental Clerks	89	99	26	14	\$30,150
41-2022	Parts Salespersons	147	161	59	1	\$33,430
41-2031	Retail Salespersons	1049	1186	391	2	\$26,540
41-3011	Advertising Sales Agents	3	6	3	N/A	\$54,540
41-3021	Insurance Sales Agents	59	69	21	N/A	\$84,870
41-3031	Securities, Commodities, and Financial Services Sales Agents	10	12	4	N/A	\$74,540
41-3041	Travel Agents	4	4	1	N/A	\$39,190
41-3099	Sales Representatives, Services, All Other	203	256	103	N/A	\$68,220
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	368	415	118	N/A	\$86,120
41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	865	976	279	N/A	\$62,380
41-9011	Demonstrators and Product Promoters	13	16	6	N/A	\$35,060
41-9021	Real Estate Brokers	4	5	1	N/A	\$70,490
41-9022	Real Estate Sales Agents	19	25	10	N/A	\$43,880
41-9031	Sales Engineers	59	61	18	N/A	\$94,910
41-9041	Telemarketers	43	56	21	N/A	\$25,170
41-9091	Door-to-Door Sales Workers, News and Street Vendors, and Related Workers	1	1	0	N/A	\$26,730
41-9799	Sales and Related Workers, All Other	40	46	15	N/A	\$42,960
43-1011	First-Line Supervisors of Office and Administrative Support Workers	387	450	149	12	\$55,720
43-2011	Switchboard Operators, Including Answering Service	13	14	5	N/A	\$28,130
43-3011	Bill and Account Collectors	74	78	16	N/A	\$38,280



43-3021	Billing and Posting Clerks	114	145	47	N/A	\$35,870
43-3031	Bookkeeping, Accounting, and Auditing Clerks	615	718	159	6	\$39,960
43-3051	Payroll and Timekeeping Clerks	65	75	21	N/A	\$43,700
43-3061	Procurement Clerks	26	27	9	N/A	\$40,600
43-3071	Tellers	4	5	2	N/A	\$27,270
43-4011	Brokerage Clerks	1	1	0	N/A	\$47,250
43-4041	Credit Authorizers, Checkers, and Clerks	8	7	2	N/A	\$35,920
43-4051	Customer Service Representatives	648	751	254	20	\$37,590
43-4071	File Clerks	31	30	7	N/A	\$28,240
43-4081	Hotel, Motel, and Resort Desk Clerks	2	3	2	N/A	\$23,920
43-4111	Interviewers, Except Eligibility and Loan	36	44	15	N/A	\$37,050
43-4121	Library Assistants, Clerical	1	2	1	N/A	\$33,720
43-4131	Loan Interviewers and Clerks	34	33	5	N/A	\$40,430
43-4151	Order Clerks	90	98	29	N/A	\$31,070
43-4161	Human Resources Assistants, Except Payroll and Timekeeping	40	46	15	N/A	\$40,840
43-4171	Receptionists and Information Clerks	181	222	86	1	\$28,860
43-4181	Reservation and Transportation Ticket Agents and Travel Clerks	26	30	8	0	\$34,550
43-4199	Information and Record Clerks, All Other	15	18	6	N/A	\$41,130
43-5011	Cargo and Freight Agents	63	80	30	0	\$38,430
43-5021	Couriers and Messengers	67	85	32	N/A	\$23,600
43-5032	Dispatchers, Except Police, Fire, and Ambulance	58	67	18	2	\$36,360
43-5041	Meter Readers, Utilities	30	29	7	0	\$44,420
43-5061	Production, Planning, and Expediting Clerks	249	257	62	N/A	\$50,570
43-5071	Shipping, Receiving, and Traffic Clerks	326	315	57	4	\$30,820
43-5081	Stock Clerks and Order Fillers	360	348	61	N/A	\$24,470
43-5111	Weighers, Measurers, Checkers, and Samplers, Recordkeeping	22	25	11	N/A	\$25,660
43-6011	Executive Secretaries and Executive Administrative Assistants	481	571	143	4	\$48,640
43-6012	Legal Secretaries	3	3	1	N/A	\$49,250
43-6013	Medical Secretaries	26	35	11	N/A	\$34,570
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	599	658	125	3	\$37,870
43-9011	Computer Operators	15	15	2	N/A	\$43,220
43-9021	Data Entry Keyers	66	64	11	N/A	\$30,650
43-9022	Word Processors and Typists	7	7	1	N/A	\$38,530
43-9041	Insurance Claims and Policy Processing Clerks	98	94	20	N/A	\$36,410
43-9051	Mail Clerks and Mail Machine Operators, Except Postal Service	16	21	7	N/A	\$29,920



43-9061	Office Clerks, General	886	1056	299	8	\$30,810
43-9071	Office Machine Operators, Except Computer	7	8	3	N/A	\$31,240
43-9111	Statistical Assistants	5	6	1	N/A	\$50,920
43-9799	Office and Administrative Support Workers, All Other	40	49	16	N/A	\$32,050
45-1011	First-Line Supervisors of Farming, Fishing, and Forestry Workers	4	4	1	N/A	\$48,480
45-2011	Agricultural Inspectors	8	9	3	N/A	\$52,100
45-2041	Graders and Sorters, Agricultural Products	6	6	2	N/A	\$22,590
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	354	421	134	7	\$72,870
47-2011	Boilermakers	34	38	14	N/A	\$46,590
47-2021	Brickmasons and Blockmasons	13	14	3	N/A	\$63,800
47-2022	Stonemasons	3	3	1	N/A	\$41,420
47-2031	Carpenters	338	371	92	5	\$53,170
47-2044	Tile and Marble Setters	3	4	1	N/A	\$43,730
47-2051	Cement Masons and Concrete Finishers	157	189	53	N/A	\$48,460
47-2061	Construction Laborers	517	625	142	40	\$38,730
47-2071	Paving, Surfacing, and Tamping Equipment Operators	38	47	15	N/A	\$56,650
47-2073	Operating Engineers and Other Construction Equipment Operators	247	322	122	15	\$69,190
47-2081	Drywall and Ceiling Tile Installers	7	9	3	N/A	\$52,610
47-2082	Tapers	2	3	1	N/A	\$52,820
47-2111	Electricians	635	714	220	75	\$54,630
47-2121	Glaziers	5	6	2	N/A	\$51,960
47-2131	Insulation Workers, Floor, Ceiling, and Wall	5	6	3	N/A	\$46,790
47-2132	Insulation Workers, Mechanical	58	66	26	N/A	\$44,940
47-2141	Painters, Construction and Maintenance	509	603	186	N/A	\$42,230
47-2151	Pipelayers	30	36	13	N/A	\$53,050
47-2152	Plumbers, Pipefitters, and Steamfitters	922	1051	348	2	\$59,010
47-2161	Plasterers and Stucco Masons	6	5	1	N/A	\$50,040
47-2171	Reinforcing Iron and Rebar Workers	5	7	2	N/A	\$61,640
47-2181	Roofers	4	5	1	N/A	\$49,310
47-2211	Sheet Metal Workers	251	266	50	0	\$57,690
47-2221	Structural Iron and Steel Workers	26	30	8	N/A	\$63,300
47-3011	Helpers--Brickmasons, Blockmasons, Stonemasons, and Tile and Marble Setters	3	3	1	N/A	\$34,900
47-3012	Helpers--Carpenters	8	13	6	N/A	\$31,600
47-3013	Helpers--Electricians	63	76	26	2	\$27,520
47-3014	Helpers--Painters, Paperhangers, Plasterers, and Stucco Masons	23	25	8	N/A	\$28,030
47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	117	156	65	N/A	\$30,540

47-3019	Helpers, Construction Trades, All Other	11	13	5	N/A	\$26,140
47-4011	Construction and Building Inspectors	52	64	25	N/A	\$74,020
47-4021	Elevator Installers and Repairers	17	21	8	N/A	\$91,540
47-4031	Fence Erectors	42	52	19	N/A	\$37,660
47-4041	Hazardous Materials Removal Workers	5	7	3	N/A	\$40,240
47-4071	Septic Tank Servicers and Sewer Pipe Cleaners	6	8	3	N/A	\$34,960
47-4799	Construction and Related Workers, All Other	17	21	8	N/A	\$36,480
47-5021	Earth Drillers, Except Oil and Gas	14	16	5	0	\$51,600
47-5081	Helpers--Extraction Workers	6	7	2	N/A	\$29,700
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	198	226	71	10	\$71,020
49-2011	Computer, Automated Teller, and Office Machine Repairers	43	45	10	N/A	\$38,920
49-2021	Radio, Cellular, and Tower Equipment Installers and Repairs	4	4	1	N/A	\$33,130
49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers	44	56	18	-1	\$52,850
49-2091	Avionics Technicians	5	5	1	N/A	\$55,240
49-2092	Electric Motor, Power Tool, and Related Repairers	12	13	2	N/A	\$44,980
49-2093	Electrical and Electronics Installers and Repairers, Transportation Equipment	35	30	1	N/A	\$55,640
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment	59	57	10	N/A	\$49,730
49-2095	Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	2	2	1	N/A	\$73,550
49-2096	Electronic Equipment Installers and Repairers, Motor Vehicles	8	8	2	N/A	\$35,280
49-2097	Electronic Home Entertainment Equipment Installers and Repairers	14	13	2	N/A	\$39,480
49-2098	Security and Fire Alarm Systems Installers	21	26	9	N/A	\$50,180
49-3011	Aircraft Mechanics and Service Technicians	9	10	3	N/A	\$54,800
49-3021	Automotive Body and Related Repairers	151	175	54	N/A	\$42,840
49-3023	Automotive Service Technicians and Mechanics	112	127	39	N/A	\$43,480
49-3031	Bus and Truck Mechanics and Diesel Engine Specialists	64	71	18	2	\$51,950
49-3041	Farm Equipment Mechanics and Service Technicians	3	4	1	N/A	\$38,300
49-3042	Mobile Heavy Equipment Mechanics, Except Engines	34	44	17	N/A	\$53,170
49-3051	Motorboat Mechanics and Service Technicians	55	60	17	-1	\$42,020
49-3052	Motorcycle Mechanics	35	39	11	N/A	\$37,330
49-3053	Outdoor Power Equipment and Other Small Engine Mechanics	9	9	3	N/A	\$32,650
49-3091	Bicycle Repairers	31	34	10	N/A	\$25,020
49-3092	Recreational Vehicle Service Techs	19	21	6	1	\$40,600

49-3093	Tire Repairers and Changers	87	97	28	N/A	\$26,760
49-9011	Mechanical Door Repairers	3	4	1	N/A	\$56,210
49-9012	Control and Valve Installers and Repairers, Except Mechanical Door	30	35	10	0	\$59,030
49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	389	515	183	N/A	\$52,770
49-9031	Home Appliance Repairers	33	36	8	N/A	\$32,880
49-9041	Industrial Machinery Mechanics	105	136	47	N/A	\$54,390
49-9043	Maintenance Workers, Machinery	34	36	7	N/A	\$46,750
49-9044	Millwrights	29	29	5	N/A	\$53,280
49-9051	Electrical Power-Line Installers and Repairers	27	33	14	N/A	\$82,520
49-9052	Telecommunications Line Installers and Repairers	36	44	14	N/A	\$49,590
49-9062	Medical Equipment Repairers	17	21	8	N/A	\$54,480
49-9069	Precision Instrument and Equipment Repairers, All Other	16	19	6	N/A	\$48,560
49-9071	Maintenance and Repair Workers, General	353	408	109	N/A	\$36,540
49-9091	Coin, Vending, and Amusement Machine Servicers and Repairers	3	4	1	N/A	\$33,600
49-9092	Commercial Divers	1	2	0	N/A	\$82,360
49-9096	Riggers	73	75	13	N/A	\$52,660
49-9098	Helpers--Installation, Maintenance, and Repair Workers	79	92	43	2	\$27,260
49-9799	Installation, Maintenance, and Repair Workers, All Other	80	89	21	N/A	\$35,370
51-1011	First-Line Supervisors of Production and Operating Workers	479	488	61	1	\$59,790
51-2021	Coil Winders, Tapers, and Finishers	11	9	1	N/A	\$33,120
51-2022	Electrical and Electronic Equipment Assemblers	342	311	26	N/A	\$29,850
51-2023	Electromechanical Equipment Assemblers	78	81	13	N/A	\$32,710
51-2041	Structural Metal Fabricators and Fitters	254	260	47	-4	\$35,630
51-2091	Fiberglass Laminators and Fabricators	277	249	22	10	\$29,030
51-2092	Team Assemblers	581	569	83	N/A	\$26,380
51-2099	Assemblers and Fabricators, All Other	107	108	18	N/A	\$30,330
51-3011	Bakers	5	6	2	N/A	\$24,240
51-3021	Butchers and Meat Cutters	14	18	8	N/A	\$28,440
51-3022	Meat, Poultry, and Fish Cutters and Trimmers	10	14	6	N/A	\$23,450
51-3092	Food Batchmakers	3	3	1	N/A	\$20,250
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	44	54	17	N/A	\$39,680
51-4012	Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic	1	1	1	N/A	\$53,520
51-4021	Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic	26	30	8	N/A	\$24,750

51-4022	Forging Machine Setters, Operators, and Tenders, Metal and Plastic	3	4	1	0	\$25,190
51-4023	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	10	12	3	N/A	\$33,030
51-4031	Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	62	58	0	0	\$30,520
51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	15	15	2	N/A	\$30,160
51-4033	Grinding, Lapping, Polishing, and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Plastic	41	41	6	N/A	\$29,100
51-4034	Lathe and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic	2	2	1	N/A	\$36,620
51-4035	Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic	2	2	1	N/A	\$40,720
51-4041	Machinists	275	273	40	0	\$42,620
51-4051	Metal-Refining Furnace Operators and Tenders	2	2	0	N/A	\$27,830
51-4072	Molding, Coremaking, and Casting Machine Setters, Operators, and Tenders, Metal and Plastic	56	56	8	N/A	\$35,370
51-4081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	24	25	4	N/A	\$33,760
51-4111	Tool and Die Makers	14	15	1	N/A	\$47,020
51-4121	Welders, Cutters, Solderers, and Brazers	747	820	237	13	\$40,840
51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	36	37	9	N/A	\$40,380
51-4191	Heat Treating Equipment Setters, Operators, and Tenders, Metal and Plastic	2	2	2	N/A	\$32,710
51-4192	Layout Workers, Metal and Plastic	147	201	77	N/A	\$36,160
51-4193	Plating and Coating Machine Setters, Operators, and Tenders, Metal and Plastic	6	6	1	N/A	\$28,830
51-4194	Tool Grinders, Filers, and Sharpeners	2	2	0	N/A	\$29,100
51-4199	Metal Workers and Plastic Workers, All Other	19	19	2	N/A	\$38,830
51-5111	Prepress Technicians and Workers	1	1	0	N/A	\$39,570
51-5112	Printing Press Operators	11	13	3	N/A	\$34,330
51-6011	Laundry and Dry-Cleaning Workers	1	1	0	N/A	\$21,480
51-6031	Sewing Machine Operators	33	33	8	N/A	\$22,170
51-6041	Shoe and Leather Workers and Repairers	5	5	1	N/A	\$22,390
51-6051	Sewers, Hand	1	1	0	N/A	\$21,460
51-6052	Tailors, Dressmakers, and Custom Sewers	10	9	0	N/A	\$32,220

51-6093	Upholsterers	55	55	12	N/A	\$34,750
51-6099	Textile, Apparel, and Furnishings Workers, All Other	2	2	0	N/A	\$24,940
51-7011	Cabinetmakers and Bench Carpenters	9	9	2	N/A	\$33,010
51-7021	Furniture Finishers	20	19	3	N/A	\$35,770
51-7041	Sawing Machine Setters, Operators, and Tenders, Wood	1	1	0	N/A	\$29,430
51-7042	Woodworking Machine Setters, Operators, and Tenders, Except Sawing	9	9	1	N/A	\$34,640
51-8013	Power Plant Operators	2	3	1	N/A	\$86,580
51-8021	Stationary Engineers and Boiler Operators	10	11	3	N/A	\$54,750
51-8031	Water and Wastewater Treatment Plant and System Operators	133	176	71	4	\$63,600
51-8091	Chemical Plant and System Operators	1	1	0	N/A	\$55,880
51-9011	Chemical Equipment Operators and Tenders	10	10	2	N/A	\$43,930
51-9012	Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders	3	3	0	N/A	\$36,850
51-9021	Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders	10	12	4	N/A	\$33,250
51-9022	Grinding and Polishing Workers, Hand	34	35	9	N/A	\$28,840
51-9023	Mixing and Blending Machine Setters, Operators, and Tenders	15	15	5	N/A	\$30,700
51-9031	Cutters and Trimmers, Hand	2	2	1	N/A	\$22,050
51-9032	Cutting and Slicing Machine Setters, Operators, and Tenders	4	4	1	N/A	\$30,350
51-9041	Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders	9	10	2	N/A	\$35,830
51-9061	Inspectors, Testers, Sorters, Samplers, and Weathers	530	650	214	0	\$38,610
51-9071	Jewelers and Precious Stone and Metal Workers	7	7	2	N/A	\$42,430
51-9081	Dental Laboratory Technicians	9	9	2	N/A	\$38,260
51-9083	Ophthalmic Laboratory Technicians	3	3	1	N/A	\$29,970
51-9111	Packaging and Filling Machine Operators and Tenders	57	62	13	N/A	\$26,370
51-9121	Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	45	46	9	0	\$32,630
51-9122	Painters, Transportation Equipment	160	161	30	N/A	\$37,430
51-9123	Painting, Coating, and Decorating Workers	2	2	0	N/A	\$33,250
51-9141	Semiconductor Processors	13	11	2	N/A	\$32,780
51-9151	Photographic Process Workers and Processing Machine Operators	10	13	5	N/A	\$26,620
51-9191	Adhesive Bonding Machine Operators and Tenders	7	8	1	N/A	\$29,220
51-9192	Cleaning, Washing, and Metal Pickling Equipment Operators and Tenders	1	1	0	N/A	\$22,100

51-9194	Etchers and Engravers	2	3	0	N/A	\$24,710
51-9195	Molders, Shapers, and Casters, Except Metal and Plastic	2	2	1	N/A	\$31,330
51-9198	Helpers--Production Workers	179	184	30	-2	\$24,800
51-9399	Production Workers, All Other	85	87	20	N/A	\$30,200
53-1021	First-Line Supervisors of Helpers, Laborers, and Material Movers, Hand	58	69	21	N/A	\$44,060
53-1031	First-Line Supervisors of Transportation and Material-Moving Machine and Vehicle Operators	44	49	12	N/A	\$57,040
53-2012	Commercial Pilots	7	8	3	N/A	\$81,050
53-3021	Bus Drivers, Transit and Intercity	1	2	0	N/A	\$29,230
53-3031	Driver/Sales Workers	71	77	18	N/A	\$30,270
53-3032	Heavy and Tractor-Trailer Truck Drivers	299	348	98	3	\$41,020
53-3033	Light Truck or Delivery Services Drivers	261	294	75	1	\$35,660
53-3041	Taxi Drivers and Chauffeurs	5	7	2	N/A	\$21,830
53-3099	Motor Vehicle Operators, All Other	22	25	7	N/A	\$35,600
53-5011	Sailors and Marine Oilers	93	106	46	N/A	\$28,570
53-5021	Captains, Mates, and Pilots of Water Vessels	156	179	71	0	\$79,660
53-6021	Parking Lot Attendants	3	5	2	N/A	\$22,180
53-6031	Automotive and Watercraft Service Attendants	8	8	3	N/A	\$23,210
53-6051	Transportation Inspectors	5	6	2	N/A	\$66,560
53-6061	Transportation Attendants, Except Flight Attendants	41	48	13	N/A	\$22,400
53-6099	Transportation Workers, All Other	3	4	1	N/A	\$30,980
53-7011	Conveyor Operators and Tenders	6	7	2	N/A	\$33,480
53-7021	Crane and Tower Operators	69	77	23	N/A	\$69,230
53-7051	Industrial Truck and Tractor Operators	154	169	51	0	\$35,410
53-7061	Cleaners of Vehicles and Equipment	80	90	29	N/A	\$22,120
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	662	735	247	-4	\$26,550
53-7063	Machine Feeders and Offbearers	9	9	1	N/A	\$23,240
53-7064	Packers and Packagers, Hand	117	129	39	N/A	\$20,720
53-7081	Refuse and Recyclable Material Collectors	1	2	0	N/A	\$43,860
53-7199	Material Moving Workers, All Other	13	15	3	N/A	\$41,500

## Appendix C – Career Pathways

### Career Path for General and Operations Managers

SOC Code: 11-1021

#### Chief executives

mean wage: **\$192,610** / seniority wage: N/A  
typical education: **Bachelor's Degree**  
typical experience: **more than 10 years**  
typical on-th-job training: **1 -2 years**

long-term S.D. maritime / nat'l demand:  
**lowest** quintile / **low** quintile

#### Marketing managers

mean wage: **\$130,840** / seniority wage: N/A  
typical education: **Bachelor's Degree**  
typical experience: **4 - 6 years**  
typical on-th-job training: **3 - 6 months**

long-term S.D. maritime / nat'l demand:  
**middle** quintile / **high** quintile

#### Sales managers

#### General and operations managers

mean wage: **\$128,880** / seniority wage: N/A  
typical education: **Associate's Degree**  
typical experience: **4 - 6 years**  
typical on-th-job training: **6 months - 1 year**

long-term S.D. maritime / nat'l demand:  
**lowest** quintile / **lowest** quintile

#### Financial managers

mean wage: **\$126,980** / seniority wage: N/A  
typical education: **Bachelor's Degree**  
typical experience: **6 - 8 years**  
typical on-th-job training: **1 - 3 months**

long-term S.D. maritime / nat'l demand:  
**low** quintile / **lowest** quintile

#### Human resources managers

mean wage: **\$117,520** / seniority wage: N/A  
typical education: **Bachelor's Degree**  
typical experience: **4 - 6 years**  
typical on-th-job training: **1 month**

long-term S.D. maritime / nat'l demand:  
**low** quintile / **middle** quintile

#### General managers

mean wage: **\$118,330** / seniority wage: **\$172,460**  
typical education: **Bachelor's Degree**  
typical experience: **4 - 6 years**  
typical on-th-job training: **1 month**

long-term S.D. maritime / nat'l demand:  
**low** quintile / **middle** quintile

#### Purchasing managers

mean wage: **\$112,700** / seniority wage: **\$154,280**  
typical education: **Bachelor's Degree**  
typical experience: **6 - 8 years**  
typical on-th-job training: **1 - 3 months**

long-term S.D. maritime / nat'l demand:  
**lowest** quintile / **middle** quintile



## Career Path for Construction Laborers

SOC Code: 47-2061

Operating engineers & other  
construction equipment operators

mean wage: **\$69,190** / seniority wage: **\$95,070**  
typical education: **High School Diploma**  
typical experience: **2 - 4 years**  
typical on-th-job training: **1 - 2 years**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **high** quintile

Pipelayers

mean wage: **\$53,050** / seniority wage: **\$74,060**  
typical education: **High School Diploma**  
typical experience: **1 - 3 months**  
typical on-th-job training: **1 - 3 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **highest** quintile

Construction Laborers

mean wage: **\$38,730** / seniority wage: **\$61,590**  
typical education: **High School Diploma**  
typical experience: **1 - 2 years**  
typical on-th-job training: **3 - 6 months**

long-term S.D. maritime / nat'l demand:  
**low** quintile / **low** quintile

Helpers - Pipelayers, Plumbers,  
Pipefitters, and Steamfitters

mean wage: **\$30,540** / seniority wage: **\$39,980**  
typical education: **High School Diploma**  
typical experience: **6 months - 1 year**  
typical on-th-job training: **3 - 6 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **highest** quintile

Excavating & Loading  
Machine & Dragline  
Operators

Hoist & Winch  
Operators

Septic Tank Servicers and Sewer Pipe Cleaners

mean wage: **\$34,960** / seniority wage: **\$6,220**  
typical education: **High School Diploma**  
typical experience: **1 - 2 years**  
typical on-th-job training: **3 - 6 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **high** quintile

Helpers, Construction Trades, All Other

mean wage: **\$26,140** / seniority wage: **\$38,620**  
typical education: **Any**  
typical experience: **Any**  
typical on-th-job training: **Any**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **highest** quintile

Helpers - Brickmasons, Blockmasons,  
Stonemasons, & Tile & Marble Setters

mean wage: **\$118,330** / seniority wage: **\$172,460**  
typical education: **Bachelor's Degree**  
typical experience: **4 - 6 years**  
typical on-th-job training: **1 month**

long-term S.D. maritime / nat'l demand:  
**low** quintile / **middle** quintile

## Career Path for Welders, Cutters, Solderers, and Brazers

SOC Code: 51-4121

### Structural Iron & Steel Workers

mean wage: **\$63,300** / seniority wage: **\$94,850**  
 typical education: **High School Diploma**  
 typical experience: **4 - 6 years**  
 typical on-th-job training: **1 - 2 years**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **high** quintile

Sheet Metal Workers

### Reinforcing Iron and Rebar Workers

mean wage: **\$61,640** / seniority wage: **\$83,880**  
 typical education: **High School Diploma**  
 typical experience: **1 - 3 months**  
 typical on-th-job training: **3 - 6 months**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **highest** quintile

General Construction  
& Related Workers

### Welders, Cutters, Solderers, and Brazers

mean wage: **\$40,840** / seniority wage: **\$60,900**  
 typical education: **High School Diploma**  
 typical experience: **6 months- 1 year**  
 typical on-th-job training: **1 month**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **high** quintile

### Structural Metal Fabricators and Fitters

mean wage: **\$35,360** / seniority wage: **\$50,870**  
 typical education: **High School Diploma**  
 typical experience: **6 months - 1 year**  
 typical on-th-job training: **1 - 3 months**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **middle** quintile

### Welding, Soldering, & Brazing Machine Setters, Operators, and Tenders

mean wage: **\$40,380** / seniority wage: **\$57,510**  
 typical education: **High School Diploma**  
 typical experience: **3 - 6 months**  
 typical on-th-job training: **1 months**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **highest** quintile

### Helpers - Pipelayers, Plumbers, Pipefitters, and Steamfitters

mean wage: **\$30,540** / seniority wage: **\$39,980**  
 typical education: **High School Diploma**  
 typical experience: **6 months - 1 year**  
 typical on-th-job training: **3 - 6 months**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **highest** quintile

**Career Path for Wholesale and Manufacturing Sales Representatives, exc. Scientific & Technical Products**  
SOC Code: 41-4012

**Sales Engineers**

mean wage: **\$94,910** / seniority wage: **\$146,950**  
typical education: **Bachelor's Degree**  
typical experience: **4 - 6 years**  
typical on-th-job training: **3 - 6 months**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **highest** quintile

**Sales Managers**

mean wage: **\$115,990** / seniority wage: **N/A**  
typical education: **Bachelor's Degree**  
typical experience: **6 - 8 years**  
typical on-th-job training: **1 - 3 months**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **high (4<sup>th</sup>)** quintile

**Wholesale & Manufacturing Sales Representatives of Scientific & Technical Products**

mean wage: **\$86,120** / seniority wage: **\$157,660**  
typical education: **Bachelor's Degree**  
typical experience: **2 - 4 years**  
typical on-th-job training: **3 - 6 months**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **middle** quintile

**First-Line Supervisors of Non-Retail Sales Workers**

mean wage: **\$71,330** / seniority wage: **\$113,870**  
typical education: **Bachelor's Degree**  
typical experience: **6 - 8 years**  
typical on-th-job training: **1 - 3 months**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **low (2<sup>nd</sup>)** quintile

**Wholesale & Manufacturing Sales Representatives, exc. Scientific & Technical Products**

mean wage: **\$62,380** / seniority wage: **\$104,750**  
typical education: **Some college**  
typical experience: **1 months - 2 year**  
typical on-th-job training: **3 - 6 months**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **middle** quintile

**General Sales Representatives for Services**

mean wage: **\$35,360** / seniority wage: **\$50,870**  
typical education: **High School Diploma**  
typical experience: **6 months - 1 year**  
typical on-th-job training: **1 - 3 months**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **middle** quintile

**Wholesale & Retail Buyers, exc. Farm Products**

mean wage: **\$63,270** / seniority wage: **\$129,170**  
typical education: **Some college**  
typical experience: **2 - 4 years**  
typical on-th-job training: **6 months - 1 year**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **middle** quintile

**Cost Estimators**

**Procurement Clerks**

mean wage: **\$40,600** / seniority wage: **\$54,870**  
typical education: **Post-secondary certificate**  
typical experience: **1 - 2 years**  
typical on-th-job training: **1 - 3 months**

long-term S.D.maritime / nat'l demand:  
**highest** quintile / **highest** quintile

**Supervisors of Construction & Extraction Workers**

## Career Path for Mechanical Engineers

SOC Code: 17-2141

### Aerospace Engineers

mean wage: **\$94,990** / seniority wage: **\$138,870**  
 typical education: **Bachelor's Degree**  
 typical experience: **6 - 8 years**  
 typical on-th-job training: **6 months - 1 year**

long-term S.D. maritime / nat'l demand:  
**highest quintile / high quintile**

### Material Engineers

mean wage: **\$95,810** / seniority wage: **\$125,680**  
 typical education: **Bachelor's Degree**  
 typical experience: **4 - 6 years**  
 typical on-th-job training: **3 - 6 months**

long-term S.D. maritime / nat'l demand:  
**highest quintile / middle quintile**

### Mechanical Engineers

mean wage: **\$88,790** / seniority wage: **\$121,810**  
 typical education: **Bachelor's Degree**  
 typical experience: **4 - 6 years**  
 typical on-th-job training: **3 - 6 months**

long-term S.D. maritime / nat'l demand:  
**highest quintile / high (4<sup>th</sup>) quintile**

### Industrial Engineers

mean wage: **\$82,850** / seniority wage: **\$115,250**  
 typical education: **Bachelor's Degree**  
 typical experience: **4 - 6 years**  
 typical on-th-job training: **6 months - 1 year**

long-term S.D. maritime / nat'l demand:  
**highest quintile / low (2<sup>nd</sup>) quintile**

### Commercial & Industrial Designers

mean wage: **\$59,730** / seniority wage: **\$96,070**  
 typical education: **Bachelor's Degree**  
 typical experience: **1 - 2 years**  
 typical on-th-job training: **1 month**

long-term S.D. maritime / nat'l demand:  
**highest quintile / high (4<sup>th</sup>) quintile**

### Chemical Engineers

### Civil Engineers

mean wage: **\$86,270** / seniority wage: **\$125,110**  
 typical education: **Bachelor's Degree**  
 typical experience: **2 - 4 years**  
 typical on-th-job training: **6 months - 1 year**

long-term S.D. maritime / nat'l demand:  
**highest quintile / middle quintile**

### Marine Engineers & Naval Architects

mean wage: **\$78,140** / seniority wage: **\$99,920**  
 typical education: **Bachelor's Degree**  
 typical experience: **4 - 6 years**  
 typical on-th-job training: **1 - 2 years**

long-term S.D. maritime / nat'l demand:  
**highest quintile / highest quintile**

### Aerospace Engineering & Operating Technicians

mean wage: **\$62,370** / seniority wage: **\$75,950**  
 typical education: **Bachelor's Degree**  
 typical experience: **4 - 6 years**  
 typical on-th-job training: **6 months - 1 year**

long-term S.D. maritime / nat'l demand:  
**highest quintile / lowest quintile**

## Career Path for Biological Technicians

SOC Code: 19-4021

### Microbiologists

mean wage: **\$63,170** / seniority wage: **\$91,630**  
typical education: **Masterr's Degree**  
typical experience: **1 - 2 years**  
typical on-th-job training: **1 - 3 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **middle** quintile

### General Biological Scientists

mean wage: **\$73,660** / seniority wage: **\$113,480**  
typical education: **Doctoral Degree**  
typical experience: **1 - 2 years**  
typical on-th-job training: **3 - 6 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **low (2<sup>nd</sup>)** quintile

### Medical and Clinical Laboratory Technologists

mean wage: **\$68,090** / seniority wage: **\$96,670**  
typical education: **Bachelor's Degree**  
typical experience: **1 - 2 years**  
typical on-th-job training: **1 - 3 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **low (2<sup>nd</sup>)** quintile

### Zoologists & Wildlife Biologists

mean wage: **\$67,100** / seniority wage: **\$109,400**  
typical education: **Masterr's Degree**  
typical experience: **1 - 2 years**  
typical on-th-job training: **6 months - 1 year**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **low (2<sup>nd</sup>)** quintile

### Biological Technicians

mean wage: **\$46,870** / seniority wage: **\$75,250**  
typical education: **Bachelor's Degree**  
typical experience: **1 - 2 years**  
typical on-th-job training: **3 - 6 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **high (4<sup>th</sup>)** quintile

Foresters

Conservation Scientists

Forest Science Technicians

Radiologic Technologists

### Agricultural and Food Science Technicians

mean wage: **\$29,860** / seniority wage: **\$44,360**  
typical education: **Associate's Degree**  
typical experience: **1 - 2 years**  
typical on-th-job training: **1 - 3 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **high (4<sup>th</sup>)** quintile

### Forest and Conservation Technicians

mean wage: **\$39,290** / seniority wage: **N/A**  
typical education: **Some College**  
typical experience: **6 months - 1 year**  
typical on-th-job training: **6 months - 1 year**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **high (4<sup>th</sup>)** quintile

### Forest and Conservation Workers

mean wage: **\$21,540** / seniority wage: **\$28,610**  
typical education: **Associate's Degree**  
typical experience: **2 - 4 years**  
typical on-th-job training: **6 months - 1 year**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **lowest** quintile

## Career Path for First-Line Supervisors of Construction Trades and Extraction Workers

SOC Code: 47-1011

### Architectural and Engineering Managers

mean wage: **\$140,610** / seniority wage: **N/A**  
typical education: **Bachelor's Degree**  
typical experience: **6 - 8 years**  
typical on-th-job training: **6 months - 1 year**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **low (2<sup>nd</sup>)** quintile

Petroleum  
Engineers

Civil  
Engineers

### Construction Managers

mean wage: **\$101,130** / seniority wage: **\$104,540**  
typical education: **Bachelor's Degree**  
typical experience: **4 - 6 years**  
typical on-th-job training: **1 - 2 years**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **lowest** quintile

### First-Line Supervisors of Construction Trades and Extraction Workers

mean wage: **\$72,870** / seniority wage: **\$105,010**  
typical education: **High School Diploma**  
typical experience: **1 - 2 years**  
typical on-th-job training: **2 - 4 year**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **high (4<sup>th</sup>)** quintile

### Construction and Building Inspectors

mean wage: **\$74,020** / seniority wage: **\$104,960**  
typical education: **Bachelor's Degree**  
typical experience: **2 - 4 years**  
typical on-th-job training: **3 - 6 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **high (4<sup>th</sup>)** quintile

Fire Inspectors  
and Investigators

### Inspectors, Testers, Sorters, Samplers, and Weighers

mean wage: **\$38,610** / seniority wage: **\$61,400**  
typical education: **High School Diploma**  
typical experience: **6 months - 1 year**  
typical on-th-job training: **1 - 3 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **low (2<sup>nd</sup>)** quintile

### Weighers, Measurers, Checkers, and Samplers, Recordkeeping

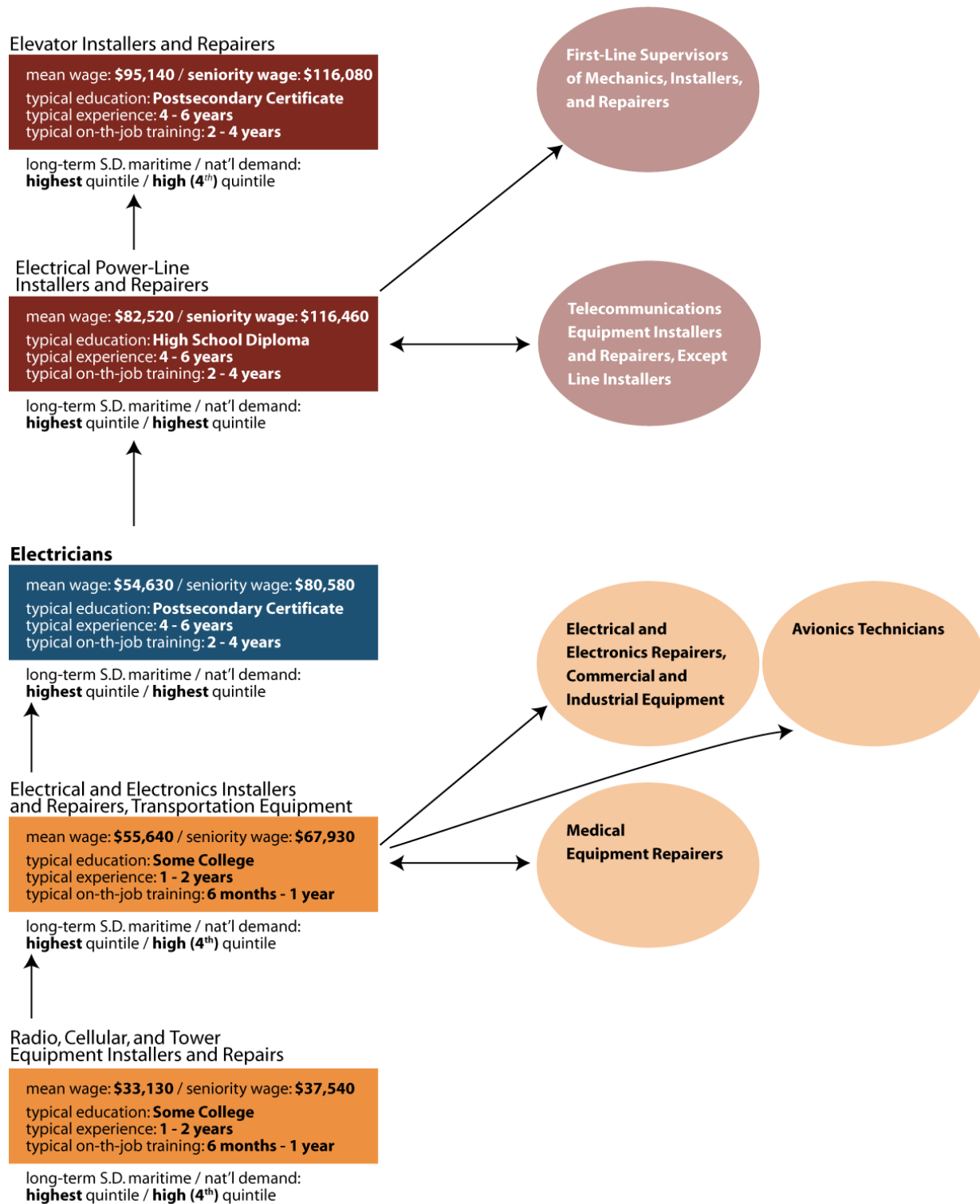
mean wage: **\$25,660** / seniority wage: **\$39,070**  
typical education: **High School Diploma**  
typical experience: **1 - 2 years**  
typical on-th-job training: **1 - 3 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **highest** quintile



# *Career Path for First-Line Supervisors of Construction Trades and Extraction Workers*

SOC Code: 47-1011





## Career Path for Plumbers, Pipefitters, and Steamfitters

SOC Code: 47-2152

### Construction Managers

mean wage: **\$101,130** / seniority wage: **\$104,540**  
 typical education: **Bachelor's Degree**  
 typical experience: **4 - 6 years**  
 typical on-th-job training: **1 - 2 years**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **lowest** quintile

Civil  
Engineers

### First-Line Supervisors of Construction Trades and Extraction Workers

mean wage: **\$72,870** / seniority wage: **\$105,010**  
 typical education: **High School Diploma**  
 typical experience: **2 - 4 years**  
 typical on-th-job training: **1 - 2 years**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **high (4<sup>th</sup>)** quintile

### Plumbers, Pipefitters, and Steamfitters

mean wage: **\$59,010** / seniority wage: **\$94,340**  
 typical education: **Postsecondary Certificate**  
 typical experience: **2 - 4 years**  
 typical on-th-job training: **2 - 4 years**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **highest** quintile

### Heating, Air Conditioning, and Refrigeration Mechanics and Installers

mean wage: **\$52,770** / seniority wage: **\$71,040**  
 typical education: **Postsecondary Certificate**  
 typical experience: **2 - 4 years**  
 typical on-th-job training: **1 - 2 years**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **highest** quintile

### Sheet Metal Workers

mean wage: **\$57,690** / seniority wage: **\$83,250**  
 typical education: **High School Diploma**  
 typical experience: **1 - 2 years**  
 typical on-th-job training: **6 months - 1 year**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **middle** quintile

### General Maintenance and Repair Workers

mean wage: **\$36,540** / seniority wage: **\$55,940**  
 typical education: **Postsecondary Certificate**  
 typical experience: **2 - 4 years**  
 typical on-th-job training: **3 - 6 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **low (2<sup>nd</sup>)** quintile

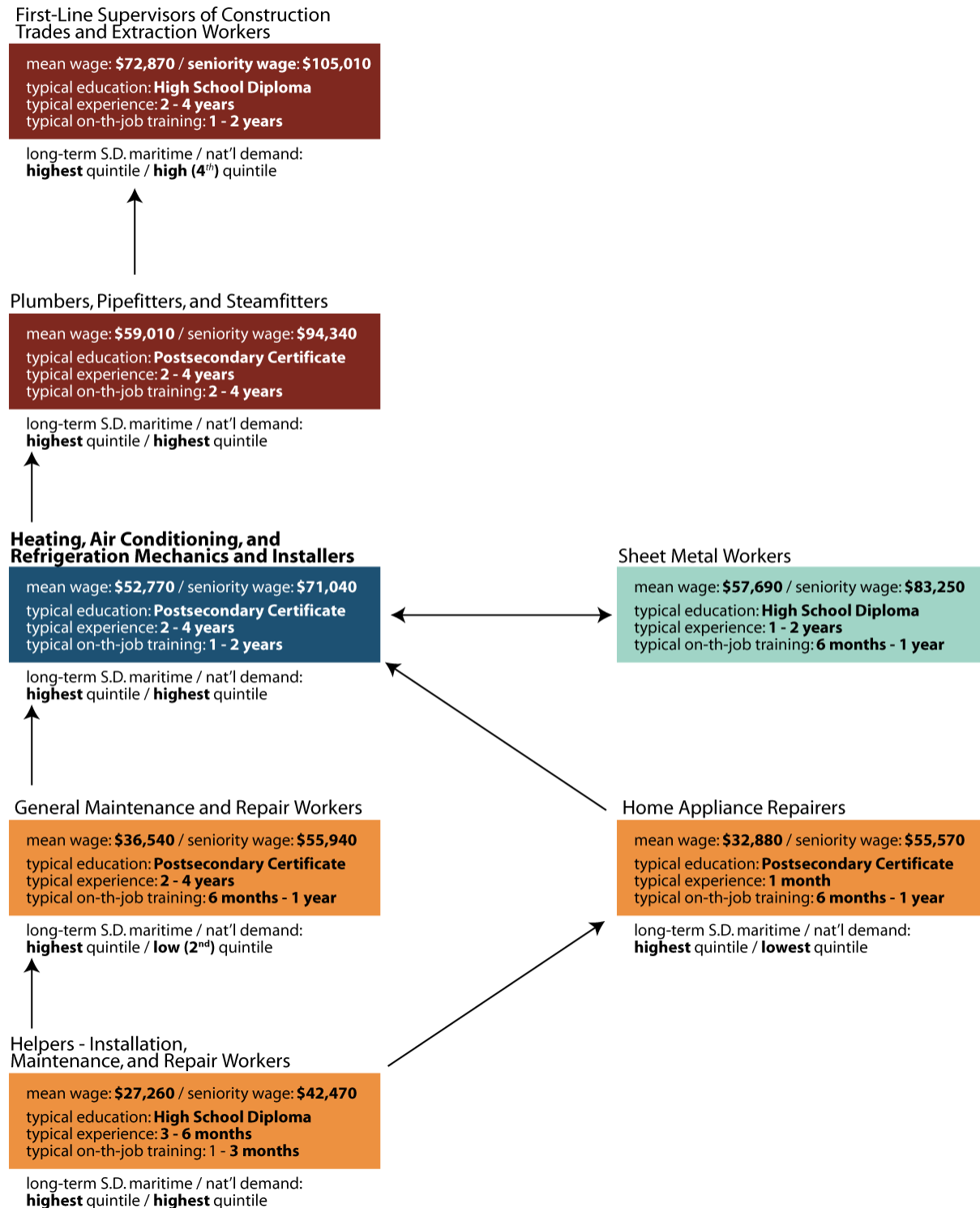
### Layout Workers, Metal and Plastic

mean wage: **\$36,160** / seniority wage: **\$48,970**  
 typical education: **High School Diploma**  
 typical experience: **1 month**  
 typical on-th-job training: **3 - 6 months**

long-term S.D. maritime / nat'l demand:  
**highest** quintile / **low (2<sup>nd</sup>)** quintile

## Career Path for Heating, Air Conditioning, and Refrigeration Mechanics and Installers

SOC Code: 49-9021



## About ERISS

ERISS is a San Diego-based, award-winning firm specializing in labor market research and cutting edge, interactive, web dissemination applications. ERISS's customers include state agencies, economic and workforce development organizations, business associations, colleges and private sector businesses. To date ERISS has conducted over 300 comprehensive labor market and industry studies using its own proprietary Computer Assisted Interviewing System and has interviewed over 2,000,000 employers nationwide.

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