

# **Understanding and Predicting Changes in the Ocean Science, Technology, and Operations Workforce**

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<http://www.marinetech.org/OSTO>

## **LONG-TERM GOALS**

The goals of this workforce study are to (1) produce a more complete description of the present state of the ocean science, technology, and operations (OSTO) workforce; (2) anticipate future developments and predict the evolution of this workforce; and (3) characterize the educational programs that will be needed to respond to expected workforce changes. Initially, the project will focus on the workforce required to support current and planned ocean observing systems (OOS) efforts; it will then expand to include related sectors of the economy such as telecommunications, hydrographic surveying, the oil and gas industry and others.

## **OBJECTIVES**

Four objectives have been defined to meet the goals of this project:

- (1) Characterize the current workforce which supports ocean observing systems.
- (2) Characterize the current workforce which supports other OSTO arenas which require knowledge and skill sets similar to the OOS occupations.
- (3) Identify the types of information required to monitor the evolution of the OSTO workforce over the next two decades, identify the most probable future workforce scenarios, and design initial workforce prediction systems.
- (4) Identify education and training objectives and practices that effectively address current and anticipated OSTO workforce needs.

## **APPROACH AND WORK PLAN**

### **1. Overall Approach**

To characterize the current workforce supporting ocean observing systems and other OSTO fields, we will gather data from existing workforce studies and collect new workforce information when adequate data does not currently exist. Methods for collecting new information will include: (a) online workforce surveys; (b) focus groups to define occupations in detail; and (c) workshops to provide insight into present and future workforce and educational needs. We will also compare the OSTO workforce to those for similar non-oceanic fields (e.g., space-based Earth observing systems; weather observation, analysis, and forecasting) in order to improve our analysis and prediction of the evolution of the OSTO workforce, and assist in identifying effective practices for the education and training of this workforce.

Results gathered from data analyses will be used to identify the most probable scenarios for the evolution of the OSTO workforce, and to recommend methods for monitoring and predicting this evolution on a continuing basis. Drawing from effective practices in industry and related sectors of the economy currently undergoing rapid changes and increasing pressures from globalization, we will also identify the educational practices best suited for supporting this evolution, and propose methods for testing and monitoring the effectiveness of OSTO educational programs.

The major deliverable products of this project will be: data and subsequent reports from project surveys, focus groups, and workshops; online databases; project web site with access to surveys, project data and reports; and conference papers and journal articles.

## 2. Key Individuals and Roles

In addition to Ms. Sullivan's role as principal investigator and Dr. Murphree's role as project director, this project includes several co-PIs from various institutions and organizations. All the partners will make substantial contributions to planning and conducting the project, including participation in carrying out the four main project objectives. The following partners will also have additional responsibilities:

- Dr. Lisa Campbell and Texas A&M University will host one or more focus groups to produce knowledge and skills guidelines (KSGs) for specified occupations.
- Dr. Janice McDonnell of Rutgers University and its Institute for Marine and Coastal Studies will host and coordinate the workshop on OOS workforce data collection, analysis, and prediction.
- Dr. Sharon Franks of Scripps Institution of Oceanography and its Center for Earth Observations and Applications and Center for Educational Outreach Connections will host and coordinate the education workshop.
- Mr. Bruce Gilman and Mr. Drew Michel will: (1) develop connections between the project and ocean industries and marine professional societies; (2) recruit industry participants for the surveys, focus groups, and workshops; and (3) provide industry and professional society perspectives on OSTO workforce issues.
- Dr. Murphree and the Naval Postgraduate School will: (1) establish connections with operational military oceanography programs, including research, development, and education programs; and (2) recruit military participants for the surveys, focus groups, and workshops.
- Dr. Leslie Rosenfeld of the Naval Postgraduate School will provide assistance to all objectives and will lead the OOS survey component.

## 3. Work Plans for the Coming Year

Characterization of the OOS workforce (objective 1) is currently underway and will continue into early next year. Quantitative analyses will be performed to assess how well the data represents the intended respondent groups, calculate basic quantities (e.g., respondent demographics, means, distributions), and determine relationships between variables (e.g., relationships between employee educational background and employer provided education and training, common KSS for different occupations).

A second survey effort to characterize the OSTO workforce (objective 2) is underway and will continue through most of next year. The OSTO sectors on which we are focusing our investigations

include: basic and applied research, oil and gas, hydrographic surveying, national security, ocean forecasting, and resource management. We will analyze existing data available on the OSTO workforce and conduct surveys of additional employers. Together, the analyses of existing data and the survey results will be used to summarize the number, type, and location of OOS-like occupations, as well as the supply and demand for these occupations. Common occupations between the OOS and OSTO workforces will be identified based on survey results; these occupations will then be characterized through survey of 300 or more employees. The types of data collected and the methods used in the employer and employee surveys will be similar to those for Objective 1. Results of all surveys will again be analyzed and reported.

Assessments of related workforce data collection, analysis, and prediction systems have begun and will continue. These will be used in conjunction with the aforementioned survey results to conduct an initial identification of the major variables that affect the evolution of the OSTO workforce (objective 3). We will conduct a workshop in late May with OSTO (especially OOS) employers and employees, and workforce analysis experts from related fields, to: (1) evaluate the results of our data analyses related to workforce prediction; (2) identify relevant lessons from analyses of other science, technology, and operational workforces; (3) determine the most probable workforce scenarios as OOS evolve over the next 20 years (i.e., create consensus predictions), with clear descriptions of underlying assumptions about critical variables (e.g., economic and technological factors); (4) critique and draw lessons from the results of our investigations into existing workforce monitoring and prediction systems; and (5) produce recommendations for developing an integrated and routine OSTO data collection, monitoring, and prediction system.

Tasks directed toward identifying effective education practices (objective 4) that are scheduled for completion in the upcoming year include: (1) synthesizing the results of prior OSTO education studies with results from objectives 1-3; (2) identifying gaps in the process of educating the OSTO workforce; (3) identifying gaps in the data sets needed to determine the most effective methods for educating the OSTO workforce; and (4) developing hypotheses for effective education of this workforce. A workshop on ocean workforce education is scheduled for fall 2008 at Scripps Institution of Oceanography.

## **WORK COMPLETED**

We have developed an online tool for collecting and analyzing data from OOS employers, including organizations that are members of regional OOS, NPS, SIO, TAMU, RU, and federal government organizations (e.g., Naval Oceanographic Office, NOAA). Preliminary data has been analyzed. Initial interviews with key supervisors and senior managers have been scheduled. We are preparing online tools for collecting and analyzing data on the broader OSTO workforce. We have reviewed and synthesized workforce prediction studies in related science, technology, and operations fields and have completed a draft report.

We have conducted a number of meetings to coordinate and collaborate with related workforce, professional development, and education efforts being conducted by NOAA, USGS, Naval Meteorology and Oceanography Center, Ocean Research and Resources Advisory Panel (ORRAP), Department of Labor, Marine Technology Society, universities, and others. These meetings have been very useful to our project in giving us access to existing data and data analyses, and providing opportunities for us to collect data. We have organized an ocean workforce session, and a workshop on the future of the OSTO workforce, that will be held at the Ocean Sciences Meeting in March 2007.

The session and workshop will be used to disseminate information from our project, collect information from related projects, and refine the plans for our two workshops. More information on the session and workshop are available at: <http://aslo.org/orlando2008/program.html>.

## **RESULTS**

Our major results are the data sets we have developed and the data analyses we have conducted. The data sets include the initial data from our online data collection process and from collaborations with employers (e.g., Naval Meteorology and Oceanography Center). The data analyses are focused on to determining:

1. The major variables that help describe the workforce, including the status, evolution, and future of the workforce
2. The major relationships between these variables that help describe the processes that force changes in the workforce
3. Key methods for modeling these relationships to allow simulation and prediction of the workforce.

Through examinations of prior workforce studies, and discussions with OSTO organizations, we have identified a number of variables, and variable relationships, that appear to be critical in characterizing the present and future state of the OSTO workforce (e.g., variables involved in determining the supply of and demand for workers). These variables are represented in our online data collection tools. A sample image of an online survey is shown in Figures 1 and 2, and a sample result from our preliminary data analyses is shown in Figure 3.



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## Ocean Observing Systems Workforce Study Employer/Supervisor Survey

The MATE Center and collaborating institutions are conducting a study of the ocean science, technology, and operations (OSTO) workforce, with a focus on the ocean observing system (OOS) workforce. As a valued member of the ocean science community, we are asking your help to characterize your organization's workforce. This information will help our community to better understand workforce needs and design educational programs aligned with these needs. This is a confidential survey that will be entered into a large database for statistical purposes only and will not be linked to you by name.

Please use this form to collect and organize the information that you will need to complete the online survey. Please complete the online survey in one session.

Thank you,

Deidre Sullivan, *Marine Advanced Technology Education (MATE) Center*  
Tom Murphree, *Naval Postgraduate School*  
Leslie Rosenfeld, *Naval Postgraduate School*

*This project is funded by the National Oceanographic Partnership Program.  
Additional information about this project can be found at: [www.marinetech.org/OSTOworkforcestudy](http://www.marinetech.org/OSTOworkforcestudy)*

Please answer all the questions on the next four pages. This will prepare you for the online survey which must be completed in one session.

1. Your first and last name:

First   
Last

2. Name of the company/organization at which you work:

7. Name of the department/organizational unit (e.g. lab or division) in which you work:

8. How many employees are employed in the department/organizational unit for which you are completing this survey form? (Please include yourself.)

Full-time     Part-time     On-site contractors

**Figure 1. Sample image of online tool for collecting data on the workforce that supports ocean observing, analysis, and forecasting systems.**

15. For each job title/function, please indicate the number of workers, the percentage of time spent on OOS activities, entry level and experienced staff annual compensation, and difficulty in hiring entry level and experienced staff.

Using the lists of job titles/functions in the question below, please categorize the workers in your department/organizational unit.

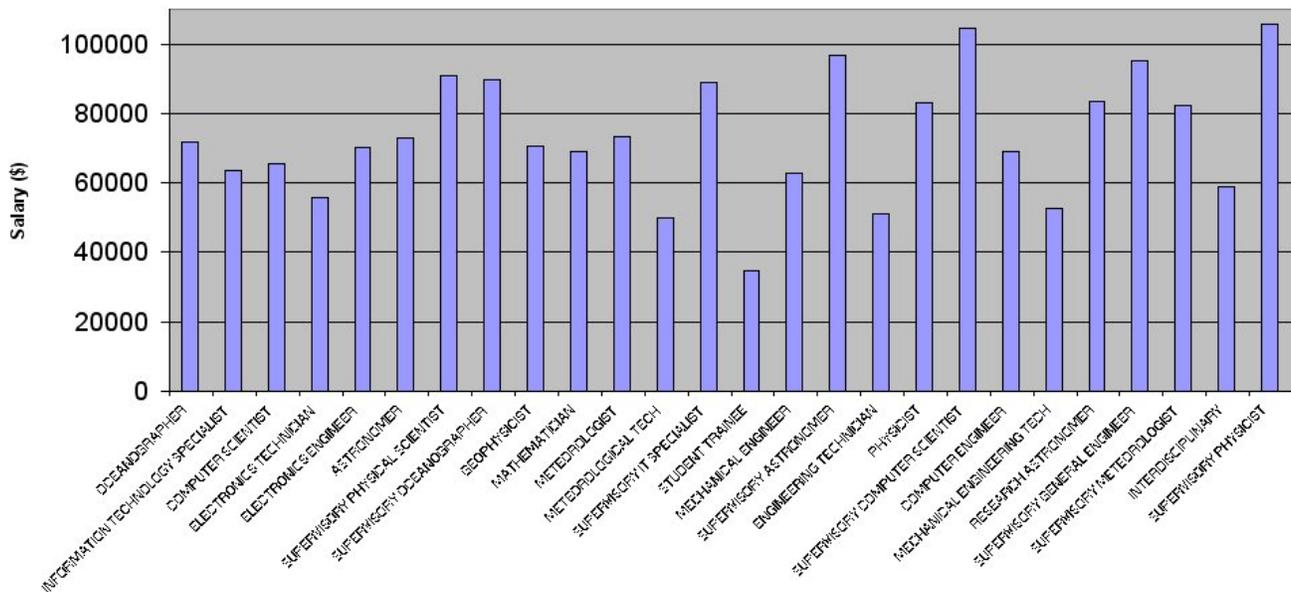
The job titles/functions are broken into four categories:

- A. Design, Operation and Maintenance of Facilities, Platforms and Instrumentation
- B. Data Collection, Analysis, Modeling, Forecasting and Interpretation of Ocean Information
- C. Data and Information Management
- D. Education, Outreach and Applications.

Please read all the job titles/functions before beginning, and assign each employee only one job title/function. We recognize that some workers may have more than one job title/function. Please do your best to assign such workers according to their main type of work. If there is not a good match between your department's job titles/functions and those listed below, you will be able to list additional job titles/functions in another area.

|   | Number of workers | Percentage of time related to OOS (0,1-24, 25-49, 50-74, 75-100) | Entry level staff annual compensation | Experienced staff annual compensation | Difficulty in hiring entry staff (easy, slightly difficult, difficult, impossible) | Difficulty in hiring experienced staff (easy, slightly difficult, difficult, impossible) | Anticipated number of hires in next two years |
|---|-------------------|--|---------------------------------------|---------------------------------------|--|--|---|
| <b>A. Design, Operation and Maintenance</b>         |                   |  |                                       |                                       |  |  |   |
| Divers and Support Personnel                        |                   |  |                                       |                                       |  |  |   |
| Engineer – Electrical                               |                   |  |                                       |                                       |  |  |   |
| Engineer – Mechanical                               |                   |  |                                       |                                       |  |  |   |
| Engineer – Structural                               |                   |  |                                       |                                       |  |  |   |
| Machinist/Welder/Fabricator/Carpenter               |                   |  |                                       |                                       |  |  |   |
| Ship Officer  |                   |  |                                       |                                       |  |  |   |
| Ship Crew   |                   |  |                                       |                                       |  |  |   |
| Technician – Electronics                            |                   |  |                                       |                                       |  |  |   |
| Technician – Hydraulics                             |                   |  |                                       |                                       |  |  |   |
| Technician – Marine                                 |                   |  |                                       |                                       |  |  |   |
| Technician – Marine Electronics                     |                   |  |                                       |                                       |  |  |   |
| Technician – Remote sensing                         |                   |  |                                       |                                       |  |  |   |
| Underwater Vehicle Pilot/Technician                 |                   |  |                                       |                                       |  |  |   |
| <b>B. Data Collection, Analysis, Modeling</b>       |                   |  |                                       |                                       |  |  |   |
| Biological Oceanographer/Marine Biologist/Ecologist |                   |  |                                       |                                       |  |  |   |
| Chemical Oceanographer                              |                   |  |                                       |                                       |  |  |   |
| Environmental Modeler/Ocean Forecaster              |                   |  |                                       |                                       |  |  |   |
| GIS Analyst/Technician                              |                   |  |                                       |                                       |  |  |   |
| Hydrographic Surveyor/Technician                    |                   |  |                                       |                                       |  |  |   |
| Hydrologist   |                   |  |                                       |                                       |  |  |   |
| Marine Geologist/Geophysicist                       |                   |  |                                       |                                       |  |  |   |
| Meteorologist/Atmospheric Scientist                 |                   |  |                                       |                                       |  |  |   |

**Figure 2. Sample image of online tool for collecting data on the workforce that supports ocean observing, analysis, and forecasting systems. This image provides an example of the types of data collected for different categories of workers.**



**Figure 3. Sample results from preliminary analyses of ocean workforce data. This sample shows annual average salaries for major occupations that support ocean observing, analysis, and forecasting systems. For this preliminary data set, the approximate annual average salaries range from \$35,000 for student trainees to \$105,000 for supervisory physicists and supervisory computer scientists, and the mean annual average salary for all occupations is approximately \$60,000.**

## IMPACT AND APPLICATIONS

The results from this project will contribute to: (1) the analysis, monitoring, and prediction of the nation’s ocean science, technology, and operations workforce; and (2) the education and professional development. Thus, these results have the potential to impact the development, implementation, and effectiveness of a wide range of ocean related activities, including resource extraction, environmental management, and national defense. Our meetings and collaborations with employers, employees, educators, and professional and industry organizations have revealed a great deal of concern about the future evolution of the ocean workforce, and a high degree of interest in the results of this project.

### National Security

Ocean science, technology, and operations are vital to national security and homeland defense. A better description of this workforce and the education programs needed to sustain it will help improve the quality of the workforce in support of these areas.

### Economic Development

Skilled workforce shortages are already affecting the bottom line of many ocean and non-ocean industries. A detailed study of the OSTO workforce and the educational infrastructure required to support it is long overdue. An in-depth study of the OSTO workforce will contribute not just to the health of the ocean economy, but to the health of our economy as a whole.

## **Science Education and Communication**

This project has the potential to profoundly influence higher education related to ocean science and technology through its efforts to characterize the educational programs that will be needed to respond to expected workforce changes in this field. This project, coupled with related efforts of the COSEE centers and the MATE Center, has the potential to reach large audiences of educators in the ocean science and technology field.

## **TRANSITIONS**

Due to nature of this project (initial focus on data collection and analysis) and the relatively recent receipt of funding for this project, no transitioning has yet occurred.

## **RELATED PROJECTS**

The MATE Center is currently conducting a NOAA-funded project entitled “Professional Certification Program for Oceanographers” with funding granted through June 2008. This project also involves a survey effort, the results of which will be beneficial to our workforce study. In turn, information gathered from the OSTO workforce surveys regarding occupations, and the education and experience required for them, will be useful in determining the need for professional certification. More information on this project may be found at <http://www.marinetech.org/cpop> .

The MATE Center has just concluded its final year of funding as part of Center for Ocean Sciences Education Excellence (COSEE) California, and has developed a user-friendly interactive web site (<http://www.OceanCareers.com>) that describes: (1) the KSS needed to work in ocean-based careers; (2) the educational institutions that help students prepare for these careers; (3) the employers in these careers, and (4) professional societies that support these careers. One of the workforce development problems this project is addressing is the lack of information on the many ocean careers that are not classified by the U.S. Department of Labor. The MATE Center is part of a new COSEE Center, COSEE Networked Ocean World that will establish online learning communities for Ocean Observing Systems.

Dr. Murphree is currently funded by ONR for a project titled “Meteorological and Oceanographic Metrics.” This project has developed and tested methods for quantitatively and objectively assessing the: (1) performance of operational meteorological and oceanographic forecasts; and (2) impacts of those forecasts on the planning and operations of the end users of the forecasts.

## **REFERENCES**

Sullivan, D., L. Rosenfeld, and T. Murphree, 2007. Certification for Oceanographic Professionals: A Needs Assessment Study. ORION Newsletter of the Ocean Research Interactive Observatory Network, Vol. 3, No. 3, 5.

## **PUBLICATIONS**

Sullivan, D., T. Murphree, and L. Rosenfeld, 2007. Understanding and Predicting Changes in the Ocean Sciences, Technology, and Operations Workforce. ORION Newsletter of the Ocean Research Interactive Observatory Network, Vol. 3, No. 3, 4.