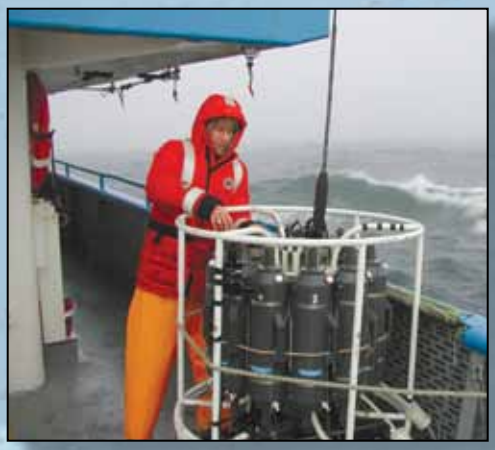
Certification for Oceanographic Professionals: A Needs Assessment Study



MATE
MARINE ADVANCED TECHNOLOGY EDUCATION CENTER

MPC
MONTEREY PENINSULA COLLEGE

Certification for Oceanographic Professionals: A Needs Assessment Study

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MARINE ADVANCED TECHNOLOGY EDUCATION CENTER

Final Project Report

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Cover

The background MODIS sea surface temperature image on the cover was adapted from one created by Rutgers University Coastal Ocean Observation Lab using data provided by NASA.

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I. Introduction

The Marine Advanced Technology Education (MATE) Center was funded by National Oceanic and Atmospheric Administration's (NOAA) National Ocean Service (NOS) and Office of Oceanic and Atmospheric Research (OAR) to assess the need for a certification program for oceanographic professionals (CPOP) in this country. This study ran from September 2006 to September 2009.

A. Definitions

Certification is a way to recognize that an individual has demonstrated professional competence and integrity in an occupational field. As John Largier of University of California Davis, an interviewee for this study, said, "Certification should be able to identify people who can put their learning into practice." (Largier, 2008)

An attendee at the March 2008 workshop at the Ocean Sciences Meeting noted, "Certification exists where formal qualifications don't guarantee competence."

Certification is typically an optional credential granted by non-governmental agencies, associations, and private sector companies. This differs from a *certificate*, or what Harris calls a *curriculum-based certification*, which is a document attesting to completion of a course of study not leading to a degree (Harris, 2001). These should not be confused with *accreditation*, which is the process of evaluating the academic qualifications or standards of an institution or program of study, or certification program, in accordance with pre-established criteria. Thus an individual can be certified, while an institution or certification program can be accredited. Another type of professional credential is *licensure*. Licenses, such as required to practice law or medicine, are granted by governmental bodies and are generally required to practice certain professions.

This project examined whether there should be a voluntary national certification program for *oceanographic professionals*. Early in the project, we encountered much ambiguity as to who was included under the term *oceanographer*. To some people the word conveyed the sense that the occupation required a graduate degree in physical oceanography, for instance. The term *oceanographers* was deemed too restrictive, and the phrase *oceanographic professionals* was substituted so as not to unintentionally limit the scope of the occupations considered. Here we use the phrase *oceanographic professionals* to denote those individuals whose primary occupational focus revolves around studying, measuring, managing, and/or forecasting the ocean, including its physics, geology, biology, and chemistry for scientific, commercial, defense, environmental protection or other purposes. Because Professional Engineers have their own system of licensing, we did not specifically consider ocean engineers in this study, although engineers in general were mentioned by many people who contributed their opinions to this study.

What Is Certification?

Professional certification is the voluntary mechanism for validating professional knowledge and expertise in a specialty. Voluntary professional certification can set standards and lead to quality for specific skills needed to perform a specific task or role. Certification allows others to aspire to this standard and quality and be recognized as skilled professionals. Voluntary professional certification programs also allow those within the profession or corporation to take control of the profession and determine its future.

— Harris, 2001

Certification is a formal process whereby a community of knowledgeable, experienced, and skilled representatives of an organization, such as [International Council on Systems Engineering (INCOSE)], provides formal recognition that a person has achieved competency in specific areas (demonstrated by education, experience, and knowledge). Certification differs from licensing in that licenses are permissions granted by a government entity for a person to practice within its regulatory boundaries. Certification also differs from a "certificate" that documents the successful completion of a training or education program.

— INCOSE, 2009

B. Motivation for the Study

There has been rapid growth in recent years in operational oceanographic activities, especially in association with the growth in ocean observing systems (OOS). The public now has access to a broad array of oceanographic products such as sea surface temperature maps, current predictions, tsunami warnings, and El Nino-Southern Oscillation forecasts. At the same time, the attention given by the public to ocean issues has greatly increased (e.g. Pew Oceans Commission, 2003; U.S. Commission on Ocean Policy, 2004; Ocean.US, 2004a, 2004b). These factors lead to the question of whether the need for a

The Time Is Ripe

Not only is the conduct of oceanography becoming more and more reliant on highly trained technicians and programmers, but the projected implementation of the Integrated Ocean Observing System and its related systems will require a whole new employment force that is not presently trained or recognized. With increased emphasis on coastal and ocean issues in the U.S. Congress and within the U.S. Ocean Action Plan, the time is ripe to develop a certification program for oceanographers and ocean engineers. There is a need to focus on education and training in a forward-thinking manner that recognizes and aims to meet current and future challenges regarding coastal and ocean issues. A certification program for oceanographers would meet that need and would benefit individuals, employers, the oceanographic community, and the overall oceanographic enterprise. Professional certification programs currently exist in ecology, meteorology, wetland science, fisheries science, and most engineering disciplines, among others. All of the certification programs have education and experience requirements and professional societies play a major role in managing and overseeing these certification programs.

— Clark, 2005

certification program for oceanographic professionals may also be increasing.

The Ecological Society of America (ESA) established a professional certification program in 1981. The ESA Board of Professional Certification recently published an editorial arguing the merits of professional certification in their field (Michener et al., 2007). The following quote would be equally applicable if one substituted *oceanography* for *ecology* and *oceanographer* for *ecologist*:

> The issues associated with environmental change raised by the media, the public, and decision makers are complex and controversial, affecting public policy, the national economy, local and regional resource use, and individual livelihoods. Ecology is central to developing requisite scientific understanding and to communicating that understanding to society. Consequently, ecologists are being brought into the dialogue with increasing frequency via print and television media, judicial testimony, and Capitol Hill briefings, among other avenues. Because of the complexity and controversy surrounding these issues, as well as the social and economic consequences of many of the proposed solutions to perceived problems, scientific credibility is paramount. (Michener et al., 2007)

The heart of the ESA's argument in favor of professional certification is the answer to the question, "How is scientific credibility established?" As they noted, the standards by which people judge others within their own profession are fairly well-established. For oceanographic researchers—just one segment of the oceanographic professionals for whom the need for certification is being assessed by this project—as for ecologists, this includes such things as academic degrees, papers published, and grants received. However, the editorial also noted:

> Because the issues surrounding our changing world require that a broad roster of scientific, engineering, and legal experts are brought into the dialogue and to the decision-making table, ecologists must also recognize how professional integrity is established within this larger community. In addition, under many circumstances, time is of the essence and it is not feasible to evaluate every individual's credentials comprehensively. (Michener et al., 2007)

This is one area where professional certification can provide benefits. Michener et al. (2007) continue: "However, as the need for ecological expertise continues to grow rapidly, ecologists must be viewed with the same level of professional legitimacy as our colleagues in engineering, law, and other disciplines in order to be effective."

Rice (2003) noted that in Canada, more ocean science is being practiced outside government and academia than in the past, and that the same may be true in the United States. Oceanography is not only practiced by academics and government institutions, but also by non-profit organizations (whose staffs include both paid employees and volunteers) and for-profit companies.

Also, assessing oceanographic professionals' qualifications has become more difficult due to the increased complexity and multidisciplinary nature of oceanography. Many people think the only route into the field is through academic programs in oceanography or marine science, but there are many non-traditional pathways into the field,

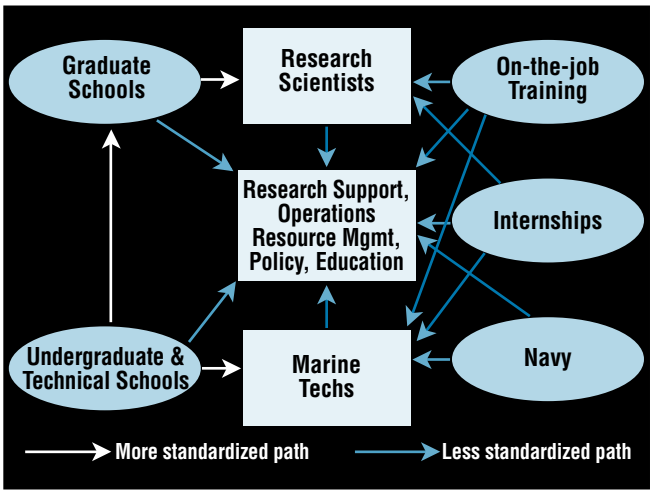

Figure 1. *Standard paths are not producing the interdisciplinary employees that many of our interviewees expressed a need for. Less standard paths may benefit from certification.*

including via the military or other professions (Figure 1). As noted by Matthew Gilligan (Savannah State University), chair of the Ocean Research and Resources Advisory Panel (ORRAP) Education Sub-panel, the route in to the practice of oceanography can be very circuitous, especially for minorities (Gilligan, 2007).

There are no existing certification programs in the United States specifically for oceanographers. A small fraction of what oceanographic professionals do is covered by existing U.S.-based certification programs in other fields (e.g., certifications in the ocean-related aspects of meteorology, fisheries, engineering, hydrography, and ecology), some of which will be described further in Section III.B.1 of this report. The Institute of Marine Engineering, Science and Technology (IMarEST) in the UK has been awarded its own Royal Charter by the Privy Council of the Queen, giving them exclusive rights to grant the credentials Chartered Marine Scientist (CMarSci) and Chartered Marine Technologist (CMarTech) (IMarEST, 2006, 2009). These credentials (discussed further in Section III.B.1.iii) are available to citizens[1] of any country who meet the requisite qualifications, which generally include at least a master's degree or the equivalent. All professional societies in the UK operate under license from the Engineering Council UK or the Science Council, and individuals can only be placed on the register of these organizations as a Chartered Engineer (CEng) or Chartered Scientist (CSci) by a professional society. Applicants wishing to register as a CMarSci must satisfy the same requirements as a CSci, for which the standards are set by the Science Council, whereas applicants wishing to register as a CMarTech must satisfy the requirements as set by the IMarEST. Two new credentials, Registered Marine Scientist (RMarSci) and Registered Marine Technologist (RMarTech), provide recognition for individuals who have only a B.S. degree but achieve the same competencies as for the chartered status. The IMarEST is the only organization in the world that holds specific marine registers.

We were unable to uncover any other specific marine science, technology, or operations professional certifications anywhere else in the world, although we came across various documents online indicating that the topic had been discussed in Canada. Registration as a professional geoscientist is required to practice geoscience in 11 provinces and territories in Canada. The Canadian Council of Professional Geoscientists is the national consortium of the regulators that govern geoscience practice in the provinces and territories of Canada. Oceanography falls outside the scope of regulated professional geoscience in all Canadian jurisdictions (Canadian Council of Professional Geoscientists, 2008).

C. Potential Benefits of a CPOP

The potential benefits of a certification program for oceanographic professionals may be expected to be similar to those for other environmental fields. Some of the points in the following have been adapted from Spinrad and the Academy of Board Certified Environmental Professionals, or ABCEP (Spinrad, 2004; Academy of Board Certified Environmental Professionals, 2005).

Employers of certified individuals may benefit by gaining:

- Enhanced confidence in the knowledge, skills and accomplishments of employees and perspective employees using accepted standards for determining qualifications[2]

Who Conducts Ocean Research and Monitoring?

The performance of science will not be monopolised by academic and government professionals. Many individuals and groups, in many settings, will be conducting components of research and monitoring. They will be welcome, because industries will be expected to cover more of their own management costs. They will be essential, because effects monitoring will be required for more ocean industries, and relative to a wide array of specified objectives and reference points. They will see the opportunities, because objectives-based management and application of control rules will make key parts of the science more systematic and orderly, even for the professionals. The professional science community will have to develop the techniques, institutions and traditions of setting performance standards for diverse science activities, and for auditing performance against them, while the doing of science will be more of a populist activity. This process is already developing in a few areas of applied science and technology. Examples include the ISO 9000 process for certification of technological processes, and the Marine Stewardship Council eco-certification process for sustainability in prosecution of fisheries.

— Rice, 2003

[1]There are practicing oceanographic professionals in the U.S. who carry the CMarSci credential, including Dr. Richard Spinrad, assistant administrator of NOAA OAR.

[2]One of our survey respondents / interviewees made the point that often, letters of reference from employers simply give dates of employment; they shy away from providing any real information about the employee's performance. Reference letters for professional certification would likely include a more useful evaluation of an individual's capabilities; and even though prospective employers won't see the actual letters, they will know that the organization granting the certification had access to that information.

- The ability to strengthen technical proposals to customers
- Enhanced professional development through continuing professional development requirements
- Improved ocean-related education and aid in development of the ocean-related workforce

Possible benefits to customers of oceanographic products and services and the public at large include:

- An increase in confidence in oceanographic products and services
- Assistance in finding qualified oceanographic professionals
- An objective measure by which those outside the field can judge scientific credentials
- Establishment and maintenance of standards of professional practice and ethical conduct

The advantages for certified individuals may include:

- Performance awards and promotions
- An increase in marketability and career opportunities
- Higher salary
- A focus for professional development by defining a professional body of knowledge. This may be especially important for people coming to the field via a non-traditional path since "[the] most common mechanism for identifying and managing a core body of knowledge is through curricular definition."(Matlock et al., 2001)
- A personal sense of achievement and pride in attaining the credential

Professional societies may also see advantages, including:

- An increase in awareness of and reliance on the oceanographic community by the public, legislators, policy makers etc. regarding such activities as consulting, testimony, support of research and operations, policy, and education
- An increased role in promoting oceanography and oceanographic professionals
- Improved coordination among professional societies on multidisciplinary issues
- Increased awareness and visibility of the breadth of ocean career opportunities

D. Project Goals

The overall goals of this project are to explore the pros and cons of certification programs in similar fields of expertise; collect and analyze data on the opinions about the need for and structure of a CPOP; report the results of our analysis; and make recommendations to the oceanographic community in order to:

- Improve ocean-related education
- Enhance professional development for oceanographic professionals
- Help meet national ocean-related workforce needs
- Assist users of oceanographic products and services in making well-informed decisions

We did not consider the issue of accreditation for ocean education programs or curricula, although it did come up in some of the meetings, interviews, and survey responses. Also, although it was suggested by some that we do so, we did not explore the issue of certifying teachers to teach ocean sciences, as teachers' primary profession is teaching—not ocean science, technology, management, monitoring, or forecasting.

It was not a goal of this project to advocate for or develop a detailed CPOP implementation plan. Development and implementation of such a plan might be follow-on activities undertaken by others, in part as a result of the recommendations included here.

E. Relationship to Ocean Sciences, Technology, and Operations Workforce Project

The CPOP needs assessment project was conducted at the same time and in close collaboration with a related project for which the lead PIs were the same as those for the CPOP project. The related project, titled *Understanding and Predicting Changes in the Ocean Sciences, Technology, and Operations Workforce*, is funded by the National Oceanographic Partnership Program and is designed to improve the understanding of the workforce that conducts ocean science, technology, and operations (OSTO) in the United States.

The project goals are to:

- Produce a more complete description of the present state of the OSTO workforce
- Anticipate future developments in this workforce
- Characterize the educational programs that will be needed to respond to those developments

Information about the type of OSTO workers most in demand, and the knowledge and skills needed to be successful in those occupations, is essential for designing education, professional development, and certification programs for prospective and present OSTO workers. Knowledge of the major factors that determine the demand for OSTO workers, including awareness of other sectors of the economy that compete for the same types of skilled workers, is important in developing and maintaining the

OSTO workforce. Results from the OSTO project are intended for use in improving aspects of OSTO workforce education, professional development, planning, and management. For example, information about the demand for and availability of qualified OSTO workers can be used to improve the planning for expansion of ocean observing and forecasting systems, and improvements in the management and use of ocean resources.

Because of the overlaps and close relationships between the CPOP and OSTO projects, many aspects of the two projects were closely coordinated. Workshops, interviews, and discussions with ocean science and technology professional societies and the Department of Labor (DOL) and other government agencies, as well as one survey, were conducted jointly by the two projects. This coordination allowed for more efficient data collection and analysis in the CPOP project. A number of people from whom we sought opinions about the need for a CPOP, expressed an interest in knowing more about the oceanographic workforce before weighing in on the desirability of a CPOP. The results from the OSTO project should prove useful in any steps that may be taken in the future towards a CPOP.

More information on the OSTO project can be found at: www.marinetech.org/OSTO/.

II. Methods

We used a variety of methods to assess the need for a CPOP. In soliciting opinions from people in the oceanographic professions about the possibility of a CPOP, we encountered early on and throughout the process, a lack of familiarity with and understanding of professional certification in general. To deal with this, we used various outreach methods to educate people about the issue. To have a common basis for discussion, we also found it necessary to formulate a straw man framework for a CPOP, which we distributed as part of a brief document (Appendix 1) that contained information about certifications in the environmental professions.

We tried to address the needs for a CPOP from the perspectives of oceanographic professionals working in a wide variety of capacities, including higher education, research, and applied or operational settings. We were also sensitive to the issues related to the diversity of disciplines within oceanography (e.g., biology, chemistry, geology, physics, technology), the various levels of expertise of oceanographic professionals, the different types of employers, and the different users of oceanographic products and services.

Over the course of this project, we gathered information through a variety of methods, and conducted investigations in a number of areas as outlined below.

A. Professional Societies

We met with the governing councils or appropriate section leadership of professional societies that have significant numbers of oceanographers as members. We also met with the ORRAP, a congressionally established panel of experts that provides independent advice and recommendations to the federal government.

B. Professional Certification Programs

We researched professional certification programs in the environmental sciences and related fields using websites and follow-up e-mails and/or phone calls. In some cases we also had access to publications and/or slide presentations that added to the information. Later in the project, following up on a lead from one of our workshop participants, we also researched a relatively new certification in systems engineering. Through another workshop participant, we became privy to the process that IEEE follows in considering whether to institute a new certification program.

C. Certification Accreditation Organizations

We used the worldwide web to research how scientific/technical professional certification programs are accredited.

D. Interviews with CeNCOOS, Industry, and Government Personnel

We conducted a few individual in-person interviews with people involved with member organizations of the Central and Northern California Ocean Observing System (CeNCOOS), the local regional OOS, as well as with a few other individuals. We conducted extensive onsite individual and group interviews, over the course of one to three days, with supervisors in three government agencies involved in ocean studies, management, and operations (Navy, NOAA, and Minerals Management Service, or MMS).

E. Surveys

The surveys were primarily conducted via the web-based tool Survey Monkey (www.surveymonkey.com). Our initial survey, conducted jointly with the OSTO project, included one multiple-choice and three open-ended questions concerning professional certification. The survey was vetted first by the OSTO principal investigators and next by participants in a meeting with government agencies held in Washington, D.C. on April 27, 2007. It was beta-tested by three local Monterey organizations. The revised version was reviewed and approved by Bob McCarthy, a survey professional at the University of California, Berkeley Survey Research Center. E-mail requests to complete this survey were distributed during the fall of 2007 to 95 supervisors at member institutions of nine of the eleven Regional Coastal Ocean Observing Systems (RCOOS). Responses were collected through February 2008. The questions on certification were to be answered from the supervisors' personal point of view. Respondents were identified by name, but they were assured that the data they provided would only be released in a pooled format, so specific data would not be tied to them individually or their institution.

An abbreviated version of the RCOOS survey was modified for industry and distributed to approximately 200 companies between January and October 2008. The industry surveys were filled out as hardcopy or electronically in an Adobe PDF document. The companies were identified, but the same assurances provided to RCOOS institutions were provided.

The second survey (Appendix 2) was devoted exclusively to the issue of certification for oceanographic professionals. We prepared a sample framework for a certification program (Appendix 1) along with findings from our research on certification programs for other relevant professions to better inform people before they completed the certification survey. The main point of the sample framework is to promote discussion of the concept of certification for oceanographic professionals and provide a common basis for that discussion. This survey was formulated using information we collected from the first survey, our interviews and meetings, and our research into other professional certification programs. We attempted to make this a PDF that could be filled in online, but ultimately were unsuccessful at creating a form that would work with multiple versions of Adobe reader on multiple computer platforms, so we instead used Survey Monkey. The online survey consisted of 19 questions, primarily multiple choice with the ability to add other answers, and a few open ended questions. The certification program framework and associated information (Appendix 1) and a request to complete the survey and pass it on to others were e-mailed to 108 people during late summer 2008. A laser pointer/pen was offered as an incentive to complete the survey. The survey remained open until March 13, 2009. Our target audience for this survey was:

- Employed oceanographic professionals, including those at federal agencies and all other types of institutions; all levels of employees including supervisors
- Marine science educators (some, not all, overlapped with the above group)
- Undergraduate and graduate students in the marine sciences
- Alumni of undergraduate and graduate marine science programs
- Users of oceanographic data, information and services including companies, non-governmental organizations, and policy makers

The e-mail requests were sent to:

- Professional society councils with whom we had met, and the ORRAP (including education and industry sub-panels)
- Attendees of March 2008 Ocean Sciences OSTO workshop
- Attendees of the June 2008 Shipboard Automated Meteorological and Oceanographic Systems (SAMOS) workshop
- University-National Oceanographic Laboratory System (UNOLS) Research Vessel Enhancement Committee
- Employees at the Commander Naval Meteorology and Oceanography Command (CNMOC), the Naval Oceanographic Office, and NOAA with whom we had been in contact concerning this project
- Attendees of the April 2007 OSTO/CPOP meeting in Washington, D.C.
- Deans and faculty members of many oceanography departments, including chairs of several departments with sizeable numbers of associate's, bachelor's and master's students in the marine sciences
- Others who had expressed interest in the project

Subsequently, the request to complete the survey was also distributed by The Oceanography Society (TOS), NOAA's NOS, and the National Data Buoy Center (NDBC). In addition, all attendees of the November 2008 OSTO/CPOP Monterey workshop and invitees to the physical science *in situ* OOS technicians' workshop were asked to complete the certification survey. A link to the survey was also posted on the project website.

Respondents to the second survey could choose to remain anonymous (if they did not care to receive the laser pointer pen). Erroneous duplicate submissions, where almost all the answers were identical and the two were received in quick succession, were identified and only the most complete survey retained.

F. Workshops

We held a lunchtime open workshop at the Ocean Sciences Meeting in Orlando, Florida on March 7, 2008. We announced the workshop on the conference website (www.aslo.org/orlando2008/workshops.html), and e-mailed the announcement to more than 100 people.

The OSTO and CPOP projects jointly sponsored an invitation-only workshop held in Monterey, California from November 10-12, 2008 (Appendix 3, www.marinetech.org/workforce/certification). Invitees were chosen with an effort to gain broad geographical representation (covering all RCOOSs) and a diverse set of expertise and interests. Individuals from federal and state government, large and small companies, community colleges, undergraduate, graduate and public marine education programs, research institutions, ocean observing systems, professional societies and certification programs, and workforce studies and policy experts were invited. An afternoon session and much discussion the following morning were devoted to certification. Attendees were asked to fill out the online CPOP survey in advance of the workshop. A post-workshop survey was sent to all attendees.

From March 19-20, 2009, the OSTO project hosted an invitation-only workshop in Monterey, California to define the job functions and needed knowledge and skills for physical science *in situ* OOS technicians. Invitees were asked to complete the online CPOP survey.

G. Educational Programs

The advent of degree or certificate programs in ocean observing or operational oceanography is a response to the growth in that area, which is also an impetus for this study. So although we were not concerned with accrediting curricula *per se*, we did investigate some new and incipient academic programs that focus on ocean observing systems or operational oceanography to see what we could learn from their perspective about what this sort of oceanographic professional needs to know. This research was carried out through the use of websites, e-mail, phone, and briefings.

H. Outreach

In order to spread the word about the project, educate people about the topic, and solicit input, we created a project website (www.marinetech.org/cpop). The Winter 2007 newsletter of the Ocean Research Interactive Observatory Networks (ORION) program featured an article about the project, and we made presentations at national and regional meetings and workshops. In addition, in April 2007, we hosted a meeting in Washington, D.C. for representatives of federal agencies involved in oceanography-related activities, and we met with a DOL representative.

III. Results

A. Meetings with professional societies and ORRAP[3]

1. **American Geophysical Union (AGU) Ocean Sciences Section Executive Committee (December 11, 2006, San Francisco, California)**

   The AGU executive director emphasized that AGU is an academic society, not a professional society. AGU does not track information on members' professional certifications or licenses. The Ocean Sciences section officers thought AGU members were not interested in certification, but nonetheless expressed interest in seeing the survey results when complete. They saw a potential benefit to certification in technology fields (e.g. electronics technicians), but not so much in oceanography. They wanted to know if we were looking at "certifying" programs as well as individuals.

2. **American Meteorological Society (AMS) Council and AMS Commission on Professional Affairs (January 14 and 15, 2007, San Antonio, Texas)**

   The council felt that there was not much overlap with the Society's Certified Consulting Meteorologist program, and noted that starting a certification from scratch is a big undertaking. One person pointed out that since the private sector will be operating the OOS, professional certification is needed. So while the council expressed limited interest at that time, they wanted us to stay in touch. Since then, the new AMS executive director has expressed more interest, and AMS has signed a memorandum of agreement (MOA; discussed further in Section III.F.2) with TOS and the Marine Technology Society (MTS; not a signatory as yet) to explore a CPOP. The AMS Commission on Professional Affairs is a good source of knowledge and experience in operating a professional certification program, and recently went through the contentious process of adding a continuing professional development requirement.

3. **American Society of Limnology and Oceanography (ASLO)**

   We corresponded with ASLO and sent them information about the CPOP project, but were unsuccessful in setting up a meeting with their governance committee.

4. **Marine Technology Society (MTS) (April 29, 2007, Houston, Texas and March 1, 2009, New Orleans, Louisiana)**

   Jill Zande of the MATE Center briefed the MTS board and council on behalf of the CPOP project in 2007, and met with the board again in 2009. At the first meeting, several members were very interested in certification. At least one had explored, or at least discussed, this with colleagues in the past; another was outspoken in his opinion that this was very important work and that MTS should be involved. Overall, there were no negative comments on the concept of certification; the response was either indifferent or positive. MTS seemed interested in playing a role. At the second meeting, the MTS board considered whether to approve the draft MOA agreeing to pursue the possibility of certification with TOS and AMS, and agreed to postpone that decision until the final report from this project was complete.

5. **The Oceanography Society (TOS) Council (March 23, 2007, by phone and March 5, 2008, Orlando, Florida)**

   TOS expressed interest in professional certification for oceanographers before the start of this project and throughout its duration. During our first meeting via conference call, they asked about the cost of running a professional certification program. They gave us a very enthusiastic response in our second (in-person) briefing, with one council member stating that certification was very important for ocean observing systems, and another who thought undergraduate students in marine science would be very interested in it. A third member thought retirees changing careers might want certification for an "encore career in oceanography." They encouraged us to engage ocean policy makers in the discussion, and formed a subcommittee of the TOS Council to look at the issue of certification.

6. **IEEE Oceanic Engineering Society (OES) (October 1, 2007, Vancouver, British Columbia)**

   Some individuals have expressed interest in certification for ocean engineers or others in the ocean workforce, but the Society in general seems to have fairly limited interest in the issue. Many felt their needs were fulfilled with Professional Engineer (PE) licensing.

7. **Ocean Research and Resources Advisory Panel (ORRAP) Education and Industry sub-panels**

[3]One or more of the CPOP PIs were present, unless otherwise noted.

(April 30, 2007, Washington, DC) and ORRAP (June 27, 2007, Washington, DC)

Feedback from the ORRAP and its sub-panels is incorporated into the motivation section (Section I.B.) of this report.

B. Professional Certification Programs

1. Environmental Science and Related Professional Certification Programs

We researched 14 professional certification programs operated by professional societies or independent certifying organizations in fields related or similar to oceanography (Table 1), from their websites. We received additional information via e-mails and/or phone calls with the program directors or their designated representative for eight of these programs. In some cases, we also had access to publications and/or slide presentations that added to the information presented below.

For 11 of these certification programs, we present information in table form only (Appendix 4). Note that some of the data in these tables may have changed since it was collected (the date of data collection is given in the top line of each table). Besides the tables in Appendix 4, more detailed information for another three programs is included below. Information summarizing all 14 programs is included in Table 2. Of the 14 certifications we looked at that are sponsored by a professional society, only one in the United States (Certified Lake Manager) requires applicants to be a member of the professional society. The charter system in the UK works a little differently. In order to be placed on the register (i.e., gain the chartered credential), individuals must be a member of the professional society administering that credential. However, it should be noted that membership and registration are not the same; for example, there is no minimum academic requirement for membership in IMarEST, although there is for the CMarSci credential.

Certification	Certifying organization	Web Site
Certified Ecologist	Ecological Society of America	www.esa.org/careers_certification/
Board Certified Environmental Engineer	American Academy of Environmental Engineers	www.aaee.net/Website/WhyCertified.htm
Certified Environmental Professional	Academy of Board Certified Environmental Professionals	www.abcep.org
Qualified Environmental Professional	Institute of Professional Environmental Practice	www.ipep.org
Registered Environmental Manager	National Registry of Environmental Professionals	www.nrep.org
Fisheries Professional	American Fisheries Society	www.fisheries.org/afs/certification.html
GIS Professional	GIS Certification Institute	www.gisci.org
ACSM-THSOA Certified Hydrographer	National Society of Professional Surveyors (member organization of ACSM)	http://www.nspsmo.org/index.cfm?fuseaction=Page.viewPage&pageId=515
Certified Lake Manager	North American Lake Management Society	http://www.nalms.org/nalmsnew/Scientist.aspx?id=35&Mid=2
Chartered Marine Scientist	Institute of Marine Engineering, Science and Technology	www.imarest.org/membership/registration
Chartered Meteorologist	Royal Meteorological Society	www.rmets.org/activities/cmet/index.php
Certified Consulting Meteorologist	American Meteorological Society	www.ametsoc.org/amscert/index.html
Certified Photogrammetrist, Certified Mapping Scientist – Remote Sensing	American Society for Photogrammetry & Remote Sensing	www.asprs.org/membership/certification
Professional Wetland Scientist	Society of Wetland Scientists	www.wetlandcert.org

Table 1. *Some professional certifications relevant to the environmental sciences. This is not a comprehensive list of environmental professional certifications.*

Several certification program websites cite monetary benefits to certified professionals as a benefit of certification:

> Firms such as Enviro-Sciences, HDR and HNTB recognize the value of the [Certified Environmental Professional, or CEP], and have awarded bonuses or salary increases of $1,000 or more to staff who earn the CEP designation. (Academy of Board Certified Environmental Professionals, 2009)

> Academy-certified engineers earn, on average, 10 percent more than other engineers. (American Academy of Environmental Engineers, or AAEE, 2009)

> A few state agencies are providing salary incentives for certified fisheries professionals. Many in the private sector also compensate for certification. (American Fisheries Society, or AFS, 2009)

To summarize the information collected from all 14 programs:

- Most are run by professional societies, but some are run by organizations created for certification.
- Four of the twelve U.S.-based programs are accredited by an independent accreditation organization. The two UK-based programs meet the requirements set by the government in that country.

Sponsor	Government-sanctioned professional society (2); professional society (8); independent agency or organization (4)
Start year	1957-2004
Accrediting organizations	International Certification Accreditation Board (1), Council of Engineering and Scientific Specialty Boards (3), UK Privy Council (2)
Recognizing organizations	Air Force, Army Corps of Engineers, Dept. of Energy, EPA, National Park Service, NOAA, U.S. Forest Service, USGS, U.S. Postal Service, state and local governments, National Association of Counties, port authorities, courts, University Consortium for GIS, National State Geographic Information Council, some companies
# people certified	51 - 1664
% applicants who fail	< 2% or "very small" (4), 5% (1), 15% (2), 36% (1)
Fees	1st time: $50 - $600; renewal: $35-$275
Education requirements	None (2); bachelor's degree (10, including some that require certain courses or that the degree is in engineering or science); master's degree (2)
Experience requirements	2 – 16 yrs; 5 yrs is most common. For some, M.S. may be used to substitute for 1-2 yrs; Ph.D. for 2-3 yrs. For one, B.S., M.S. or Ph.D. each count for 0.5 yrs experience.
Test requirements	None (7); written (4); written or oral (1); written and oral (2). In two programs, the written exam may be waived if applicant has 15-16 yrs experience.
Other requirements	References; sign code of ethics; technical report; essay; oral presentation and/or interview; membership in a professional society; be professionally engaged in the field
Continuing requirements	Point system for professional development activities (9); none (3); continuing professional development log must be submitted (2)
Recertification interval	5 yrs (8; some also have an annual fee); 3 yrs (1); 1 yr (4), none (1)
Program profitability	Small profit (2), break even (2), loss (3)

Table 2. *Summary of some pertinent information about the twelve U.S.-based certification and two UK-based chartered registration programs listed in Table 1. This information was obtained through the certifying organizations' web sites, and in eight cases with additional e-mail and/or phone contact with someone at the certifying organization. Data were collected between November 2006 and April 2008; some things may have changed since then. For some variables, the number of programs to which a given answer applies is shown in parentheses. For others, a range is given that encompasses all the answers obtained for that variable. Lists without numbers are an amalgamation of the answers given by all the programs. Note that we were unable to obtain data for every variable for every program.*

- A variety of government agencies, courts, and companies recognize these certifications.
- As of the dates of data collection, the number of individuals with any given certification was fewer than 2,000, although the number of certified Geographic Information Systems Professionals (GISPs) now exceeds that.
- Most require a bachelor's degree and at least five years relevant experience. Graduate degrees may be substituted for some of the years of experience.
- Half of the programs require an exam.
- Most have a continuing professional development requirement.
- Seven program officials were willing to disclose some limited financial information. Of these, two said their certification programs showed a small profit, two broke even, and three operated at a loss.

i. Certified GIS Professional

Geographic information systems (GIS) is a foundation for OOS and how data are collected, analyzed and presented spatially. Over the past decade or so, many professional societies and professional groups have conducted extensive research on the need and approaches to professional GIS certification. This has resulted in the recent establishment of certification programs by three organizations: GIS Certification Institute (GISCI), American Society of Photogrammetry and Remote Sensing (ASPRS), and Spatial Technology and Remote Sensing (STARS). All three of these certification programs are reviewed in Sullivan et al. (2008). Two of the certification programs, GIS Professional and ASPRS's Certified Mapping Scientist and GIS/Land Information Science certification, are also included in this study (Appendix 4). The GISP program appears to be very successful and already has more than 3,500 certified professionals, in spite of only having begun in 2004. GISCI kindly provided results from some of the research that was done in preparation for the formation of the GISP program (Grams, 2007). We were unable to incorporate all of that into this report, although the important points have been incorporated into our recommendations. Their study results will be a valuable resource if a decision is made to continue investigation into a CPOP.

ii. Certified Hydrographer

As described by Jerry Mills (NOAA/NOS), vice chairman of the American Congress on Surveying and Mapping (ACSM) / The Hydrographic Society of America (THSOA) Hydrographer Certification Board, hydrographic surveys are conducted for a variety of purposes: nautical charting, dredging, nearshore sediment transport studies, coastal engineering and fisheries habitat characterization (Mills, 2009). The first two carry with them significant liability due to their critical importance to marine navigation, and as such, are the responsibility of NOAA's Office of Coast Survey and the U.S. Army Corps of Engineers, respectively.

When both agencies began contracting for hydrographic surveying services, there was concern about the ability of contract awardees to conduct such surveys in accordance with acceptable standards. State law in every state requires persons conducting hydrographic surveys to hold a Registered Land Surveyors license. Yet both federal agencies were skeptical of the hydrographic survey skills of such land surveyors without significant previous marine experience. Hence, ACSM's Hydrographer Certification Program (Appendix 4) was established in 1981.

Subsequent to establishment of the program, both agencies were informed that certification could not be required as a prerequisite for surveyors to obtain federal contracts since certification is not equivalent to licensure. Rather, certification can be used as a factor in awarding such contracts. This ruling lessened the importance of becoming certified for many surveyors and the number of certification applications decreased. During the first 12 years of the program, 30 NOAA employees were certified, but since then very few have pursued certification due to the lack of apparent benefit to their careers. Most applications received in the past 15 years have been from private sector surveyors. The biggest challenge for the Hydrographer Certification Program, which is now cosponsored by THSOA, is determining the value to the hydrographic surveying community and making changes as needed.

iii. Chartered Marine Scientist (CMarSci) and Chartered Marine Technologist (CMarTech)

Note that in the UK, "chartered professionals" are like "certified professionals" in the United States. Commonly known as "professional registration" because competent individuals are placed on a register, these credentials are common across all engineering and science professions. IMarEST is licensed by the Science Council to award the CSci credential, and by the Engineering Council UK to award the CEng credential, and it has its own registers specific to the marine profession: CMarSci, CMarTech, and Chartered Marine Engineer (CMarEng). All these categories follow the same standards to ensure parity of esteem

across professions. As far as we have been able to determine, the CMarSci credential (Appendix 4) is the only marine science professional certification anywhere in the world, although as we have discussed, there are other programs that address some aspects of marine science.

IMarEST has a long history of dealing with engineers, but only started investing in the marine sciences in 2002, according to Graham Hockley, director of policy and professional affairs at IMarEST (Hockley, 2007). Consequently, many of the science members are students. However, this is rapidly changing and IMarEST expects that a number of these students will apply for registration in the future. Most of the Chartered Marine Scientists are in physical oceanography; a few are in biology or chemistry. Several things may contribute to the preponderance of physical oceanographers, including a program that allows Navy meteorology and oceanography (MetOcean) personnel to apply their experience towards the credential; and due to the more commercial nature of physical oceanography, many of the oceanography members work in companies employing large numbers of engineers and other professionals. Chartered status is seen as the highest standard of achievement, and those organizations wish to show that scientists are as valued as engineers (van Smirren, 2009). Hydrographers that are more involved in science rather than technology are entitled to apply for the CMarSci program, and marine biologists can choose to become Chartered Biologists or Chartered Marine Scientists.

IMarEST has not encountered much resistance to the CMarSci program from existing scientists, especially those in the commercial sector. But some academic marine scientists feel that only publications should count in assessing someone's qualifications. While there is still somewhat of a barrier with the academic community, some now see the chartered designation as an advantage.

IMarEST also confers the CMarTech title:

> Marine Technologists may be described as those individuals who have acquired an enabling package of knowledge and understanding of devices, systems, processes and other techniques created for a specific purpose in the marine environment. They are experienced in the application of this enabling knowledge and understanding through the exploitation of technology to deliver and/or sustain something that has significant technical content and, in the context of the economy, achieves commercial success; a capability, a system or a particular device. Marine Technologists are engaged in the management, use or exploitation of technology to create wealth and/or provide services. In practice they are people like hydrographers, marine law professionals, subsea technology professionals, those involved in some aspects of technical and scientific education (i.e., those working at a senior level with, or in, marine science and technology, or are somehow connected with marine science and technology, and who have significant technical knowledge and understanding, yet who are not marine scientists or engineers). (Wainwright, 2008)

Registration as a CMarTech also requires a master's degree.

In addition to chartering professionals, IMarEST also accredits educational courses in the UK, including Navy MetOcean training (MacKenzie, 2008). They have found that students want to know that what they are being taught is going to help them get a job. IMarEST accredits primarily master's programs and some bachelor's programs as well. The accreditation is free; there is no charge to the educational institution. When graduates of these accredited programs apply for CMarSci registration, their applications go through more quickly since IMarEST does not need to investigate their curricula, as they do in other cases.

IMarEST has about 40 employees, but only about seven of those are involved in the registration and accreditation missions for all engineering and marine science categories. The mentoring function is carried out solely by volunteers.

2. Other certification and licensing programs

In less detail, we explored a certification program offered by an employer and a state licensing program. We were unable to confirm the existence of a few other ocean-related certification programs that were mentioned by survey respondents or interviewees. These included certifications supposedly sponsored by the American Academy of Underwater Sciences and the American Shore and Beach Preservation Association.

i. National Weather Service (NWS) forecasters

The NWS forecaster development process (Appendix 4) is a simple and flexible alternative to the more formal national certification model that involves buy-in from many organizations (e.g., professional societies, employers, employees, educational organizations, etc.). Something similar to the NWS process might serve some of the purposes of a more formal national certification program for some types of oceanographic professionals, and at a much lower cost.

ii. Professional Geologist

A Professional Geologist license issued by

California is required by law in order to practice as a professional geologist in that state. The law states that the main reason for the licensing process is the protection of the public. Similar laws and licensing apply in most other states. We looked at California's requirements (Appendix 4) as an example. The National Association of State Boards of Geology has information on requirements in other states (National Association of State Boards of Geology, 2009).

3. **Certified Systems Engineering Professional (CSEP)**

Late in the project, following up on a lead from one of our workshop participants, we researched a relatively new certification program in systems engineering (Appendix 4), which provided some new insights and information. More importantly, it served to confirm many of our findings reached to that point. As with many of the other certification programs we explored, INCOSE operates a multi-level program (Figure 2) and has extensions for different disciplines. This is very similar to the straw man framework we laid out for a CPOP (Appendix 1).

4. **IEEE process**

Through another of our workshop participants, we became privy to the process that IEEE follows in considering whether and how to institute new certification programs (Figure 3). IEEE offers several certifications. IEEE Computer Society offers Computer Software Development Professional, and CSD Associate for entry level professionals. The IEEE Communications Society offers the Wireless Communication Engineering Technologies (WCET) certification. Other certification programs are in development or under consideration.

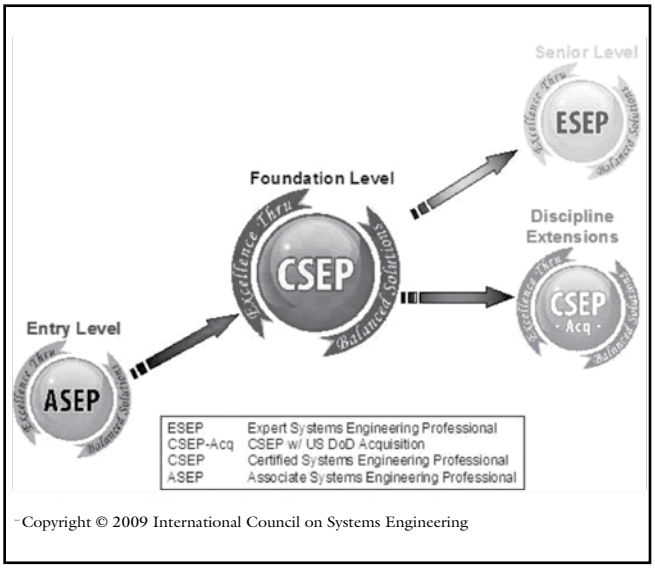

Figure 2. *INCOSE multi-level certification program.*

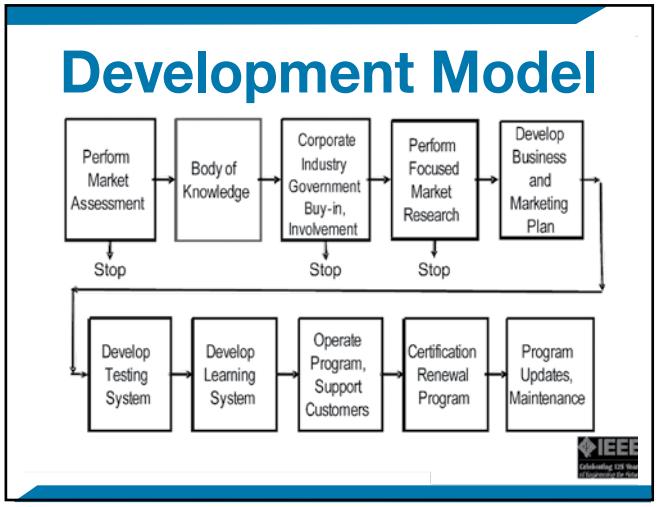

Figure 3. *IEEE process for deciding whether to proceed with new certification (courtesy of Tom Wiener).*

C. Accreditation Organizations

1. **Council of Engineering and Scientific Specialty Boards (CESB)**

Founded in 1990, CESB is "the recognized accreditation body for engineering and scientific certification and specialty certification programs." (Council of Engineering and Scientific Specialty Boards, 2009a) Most of the certifications accredited by CESB are in engineering. Among other things, CESB provides "basic criteria and guidelines for the establishment and operation of specialty certification programs for engineers, technologists, technicians, and related scientific (*sic*) [and] serves as a recognizing body for organizations that certify individuals." (Council of Engineering and Scientific Specialty Boards, 2009b) We examined the CESB-accredited certification programs of CESB member boards AAEE, ABCEP, the Institute of Professional Environmental Practice (IPEP), and the Society of Wetlands Scientists Professional Certification Program. CESB has four categories of specialty certification (Council of Engineering and Scientific Specialty Boards, 2009c). The Board Certified Environmental Engineer falls under the Professional Engineer category, while the CEP and qualified environmental professional fall into the engineering-related category. (The Professional Wetland Scientist certification from the Society of Wetland Scientists is not listed under their accredited certification programs.)

Certification program guidelines for all four categories are listed on the CESB website and cover the following issues:

- Purpose of the Certification Program
- Structure of the Certifying Body
- Resources of the Certifying Body
- Certification Program Operation

- Public Disclosure of Certification
- Responsibilities to Applicants
- Responsibilities to the Public and Consumers
- Recertification
- Titles

There are additional supplemental guidelines for each of the four categories of certification (Council of Engineering & Scientific Specialty Boards, 2009d).

2. National Commission for Certifying Agencies (NCCA)

NCCA is the accreditation division of the Institute for Credentialing Excellence (ICE). Formerly known as the National Organization of Competency Assurance (NOCA), ICE was created in 1977 to provide educational resources and best practices for organizations with certification programs. NCCA evaluates certification programs based on predetermined and standardized criteria (Institute for Credentialing Excellence, 2009a).

ICE is a leader in setting quality standards for credentialing organizations, mostly in the health field. NCCA has accredited over 190 programs representing 78 organizations (Institute for Credentialing Excellence, 2009b).

NCCA lays out the structure and development of the standards for certification programs. The standards:

> are organized into five sections: (1) Purpose, Governance, and Resources, containing five Standards (2) Responsibilities to Stakeholders, containing four Standards (3) Assessment Instruments, containing nine Standards (4) Recertification, containing two Standards, and (5) Maintaining Accreditation, containing one Standard. To earn or maintain accreditation by NCCA, the certification program must meet *all* Standards and provide evidence of compliance through the submission of required documentation. (Institute for Credentialing Excellence, 2004)

In addition,

> NCCA uses a peer review process to: establish accreditation standards; evaluate compliance with the standards; recognize organizations/programs which demonstrate compliance; and serve as a resource on quality certification. Certification organizations that submit their programs for accreditation are evaluated based on the process and products, not the content, and are therefore applicable to all professions and industries. (Institute for Credentialing Excellence, 2009c)

3. American National Standards Institute (ANSI)

Founded in 1918, ANSI administers two accreditation programs for personnel certification agencies, including one for agencies that certify food protection managers and one that is based on a new International Standard, known as ANSI/ISO/IEC 17024.

> The International Organization of Standardization (ISO) and the International Electrotechnical Commission (IEC) have developed a global, voluntary benchmark for organizations responsible for certification of personnel. Fully enacted on April 1, 2003, this international standard (ANSI/ISO/IEC 17024) was designed to harmonize the personnel certification process worldwide and create a more cost-effective global standard for workers. ANSI/ISO/IEC 17024, officially entitled General Requirements for Bodies Operating Certification Systems of Persons, is expected to play a prominent role in facilitating global standardization of the certification community, increasing mobility among countries, enhancing public safety, and protecting consumers. (IITAC International Institute, 2009)

> The process used by ANSI to accredit certification bodies is based on an international standard (ISO/IEC 17011). Adherence to a rigorous internationally recognized accreditation process ensures that the ANSI process conforms to the highest accreditation standard and represents the best practices in accreditation. ANSI is the only personnel certification accreditation body in the United States to meet nationally accepted practices for accreditation bodies. The ANSI accreditation process involves both a review of a paper application and the performance of an assessment (onsite visit) to validate information provided by each applicant. The use of an onsite assessment for accreditation of personnel certification agencies is unique to ANSI. (American National Standards Institute, 2009a)

A range of professional certifications are accredited under International Standard ANSI/ISO/IEC 17024; none of the environmental certifications that we examined are included. A list of ANSI-accredited programs is available on the organization's website (American National Standards Institute, 2009b).

4. International Certification Accreditation Board (ICAB)

One of the certification programs that we examined, the Registered Environmental Manager, is accredited by the ICAB. According to its website, ICAB "is an independent global nonprofit organization whose mission is to serve the public good by ensuring quality, credible professional credentialing

programs and procedures." Based in Glenview, Illinois, it is "governed by a Board of Regents comprised of international representatives of accredited Member Organizations as well as Public Members overseeing and ensuring the rights of the general population, government and the military." (International Certification Accreditation Board, 2009a) Accreditation requirements are posted on the website, but there is not a list of accredited certification programs. (International Certification Accreditation Board, 2009b).

5. **ASTM International (formerly known as American Society for Testing and Materials)**

ASTM International published S*tandard Practice for Assessment of Certification Programs for Environmental Professionals: Accreditation Criteria* in 1998 (ASTM International, 1998), but it was withdrawn in 2007 because of the organization's policy to withdraw any recommendation that has not been updated in eight years (ASTM International, 2009). This document referenced the CESB and NCCA standards, and among other suggestions, recommended that the certifying body "be independent from sponsoring professional organizations in matters pertaining to certification." (ASTM International, 2009)

D. Interviews

In-person individual and small-group interviews were one of our primary methods for collecting information about attitudes on certification from supervisors in government agencies dealing extensively with ocean operations and issues. Sixty-seven percent of the 75 government supervisors we interviewed expressed no opinion about CPOP (or in a very few cases were neutral), while 29 percent were positive and four percent were negative (Table 3). Twelve supervisors (one Navy, three NOS/NOAA, four NDBC/NOAA, and four from industry) could be said to be unequivocally enthusiastic about the idea. The rest of the positive opinions were expressed after some prodding from us. The attitude toward certification differed by agency, perhaps related to the number of contractors employed. For example, MMS employs very few contractors, mostly in IT. Two out of 20 MMS supervisors interviewed viewed certification negatively, concerned that requiring certification would limit the already small pool of applicants and make it even more difficult to hire employees. Only one MMS interviewee thought certification might be beneficial. At NOS, six out of 14 thought it could be beneficial, and none were outright opposed to it. Of the 31 Navy supervisors we spoke with, eight saw some potential benefits, and one was negative about it. NDBC was strongly supportive of certification, with most of the government supervisors and both of the contractor supervisors we spoke to in favor of it.

Both within the government sector alone, and also including another 13 interviews with supervisors in industry and academic research organizations (Table 3), 60-70 percent expressed no opinion about certification. However, for those with an opinion, comments ran seven to one in favor of certification for at least some categories of oceanographic professionals (Table 3).

We report here one unsolicited comment, not included in the table since it was not the result of an interview. In response to the ORION Newsletter article, we received a

Type of organization	Interviewees #	No Opinion[6] # (%)	Positive # (%)	Negative # (%)
CNMOC and NAVO[1]	31	22 (71)	8 (26)	1 (3)
NOS/NOAA[2]	14	8 (57)	6 (43)	0 (0)
NDBC/NOAA[3]	10	3 (25)	7 (75)	0 (0)
OMM/MMS[4]	20	17 (85)	1 (5)	2 (10)
Govt subtotal	75	50 (67)	22 (29)	3 (4)
Industry	6	1 (17)	5 (83)	0 (0)
Academic /Research[5]	7	3 (43)	3 (43)	1 (14)
Total	**88**	**54 (61)**	**30 (34)**	**4 (5)**

Table 3. *Results of supervisor interviews.*

[1] *Commander, Naval Meteorology and Oceanography Command and Naval Oceanographic Office, interviews conducted in Missisippi, Jan. 28-29, 2008.*

[2] *National Ocean Service, interviews conducted in Maryland, Oct. 8-10, 2008.*

[3] *National Data Buoy Center, interviews conducted in Missisippi, Apr. 29, 2009. The two contractor supervisors interviewed are included in the industry category.*

[4] *Offshore Minerals Management / Minerals Management Service, interviews conducted in Louisiana, Oct. 6-8, 2008.*

[5] *Interviews conducted during fall of 2007. Number of interviewees is small since the RCOOS survey targeted this category of organizations to seek initial opinions about certification.*

[6] *Also includes a very small number of people who were decidedly neutral.*

suggestion that two existing short courses, one in bio-acoustical oceanography and the other in applications of satellite remote sensing in biological oceanography, might serve as the basis for certification programs for those areas of expertise.

TOS past president Rick Spinrad and past secretary Mel Briscoe have been ardent advocates of professional certification for oceanographers. They formulated some of the early documents and briefs upon which the RFP for this project was based (Spinrad, 2004).

Comments from individual interviewees are listed in Appendix 5. Specific areas of expertise mentioned for possible certification are tabulated together with those from the first survey (discussed in Section III.E.1) in Table 4.

E. Surveys

1. OSTO/CPOP online survey for RCOOS member organizations

The majority of the 31 responses came from people who headed up groups at research or academic institutions (or a combination of the two), as shown in Figure 4. These include some groups that are responsible for operating components of an ocean observing system. A few companies responded, but the majority of the industry response was through other avenues, e.g. hardcopy surveys, interviews, or workshops. While a few small government labs or agencies responded via the online survey, the bulk of the input from government agencies, both military and non-military, was through the onsite interviews and workshops described elsewhere in this report.

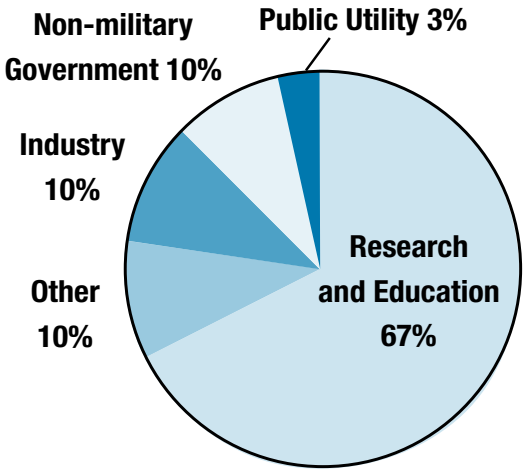

Figure 4. *The responses to the OSTO/CPOP survey for RCOOS institutions came from 31 organizations that could be characterized in the categories pictured. Note that in a few cases there were responses from more than one organizational unit within the same institution. A few institutions could conceivably fall into more than one of the categories pictured, but the primary category is captured here. Organizations that are consortia of other institutions are included in the Other category.*

In the letter inviting people to respond, we described the two different projects (OSTO and CPOP). The first part of the survey asks about the workforce for ocean observing systems and the certification questions were preceded by the following paragraph:

> We are assessing whether there is an unmet need for voluntary certification of some ocean professionals. Certification is recognition by one's colleagues and peers that an individual has demonstrated professional integrity and competence in their field. Such programs already exist for a few ocean-related professions, such as meteorology, fisheries, and diving. One potential benefit of certification includes the development of accepted standards for determining qualifications to aid in evaluation of job applicants, employees and peers.

Even so, it is obvious that some respondents answered from the perspective of the applicability for ocean observing systems. The answers to the four certification questions from these 31 respondents are summarized in Table 4.

2. OSTO/CPOP survey for industry

Twenty-five industry surveys were returned, but only ten responses included anything about certification. The companies responding included consulting companies, instrument manufacturers, and offshore services providers.

Participants were asked to "list occupations or skill sets in ocean science, technology, or operations for which you feel a new professional certification might be useful in recruiting, retaining, evaluating, and/or promoting employees."

The responses were: applications level computer science; electronics technicians or marine technicians; remote sensing technicians and professionals; oceanographic field technician, field oceanographer, and consultant physical oceanographer; all areas of data integration, data management and modeling; and offshore safety certifications. One company representative said all areas could benefit from certification, and one said that no professional certification was necessary for their needs. Another mentioned shipboard technical positions, in addition to able-bodied seamen and other ship's crew positions that are outside the scope of this study.

Finally, one company representative had a lot to say about what kinds of skills and occupations could benefit from certification including skills needed to work with: fiber optics and subsea cables, sensors, underwater optics, underwater acoustics, communications (optical, acoustic; RF, satellite, etc.), shipboard equipment (cranes, winches, lines, etc.), ocean modeling, data management, and tsunami detection. In

17. As an employer/supervisor, for which types of positions might a new certification program for ocean professionals be of value?

Response	# responses
No opinion or didn't respond (from RCOOS survey only)	10
None (from RCOOS survey only)	5
Technicians (marine, ocean observing, seagoing)	7 + **6**
Forecaster / operational oceanographer	1 + **4**
Oceanographer	1 + **3**
Marine electronics (wireless communication, ocean instrumentation)	3 + **1**
Data collection, analysis, quality assurance/ quality control (QA/QC)	3 + **1**
Engineers (coastal, marine, all types)	3
Hydrographer	**3**
Data Management	**2**
Science to applications / integrative science policy	**2**
Modeler	**2**
Data visualization	**2**
Able-bodied seamen, engineering rates, shipboard technical positions	**2**
Scientific / applications programmer	1 + **1**
Video camera maintenance	1
Underwater vehicle pilot/technician	1
High performance computing	**1**
Marine monitoring and management	**1**
All areas	**1**
Geophysicist	**1**
Remote sensing	**1**

RCOOS survey responses sum to more than 31 since some people listed more than one type of position for which they'd like to see a new professional certification program.

18. Would nationally standardized measures of employee competence, such as certification, be useful in marketing your products or services to clients and users?

Response	# responses	% of responses (for the 31 online responses only)
No	9	29
Yes	8 + **2**	26
Don't know	6 + **1**	19
Maybe	5 + **3**	16
Didn't answer	3	10

19. Are there other reasons for which you would find certification beneficial to you or your organization? If so, please list them below.

Response	# responses
No, or didn't respond (from RCOOS survey only)	21
Prospective employee/**contractor** evaluation; QC employee advancement	3 + **4**
Increase reliability of ocean observing systems	2
Continuing professional development requirements	1 + **2**
Employer pays incentive for professional certification	1
Only if it brings additional ocean observing system funding	1
Accreditation of marine science curricula or degree programs	1 + **1**
Education degree (maybe M.S.) that includes certification	1

20. What are your concerns about certification for oceanographic professionals?

Response	# responses
No answer (RCOOS survey only)	12
Field too diverse; certification too inflexible; OOS procedures too specific for certification	4 + **1**
Waste of time; no value within OOS	2
Increase bureaucracy and paperwork	1
Concern it could lead to organized union	1
That it won't change staffing issues significantly / could decrease applicant pool	1 + **1**
Drive up employment costs and need for guarantees of job stability not available under IOOS or research funding	1
None; good idea	2 + **4**
Breadth of technical disciplines may require multiple certification offerings; would be difficult to do in a one-size fits all mode	2 + **1**
Making sure it's uniform and widely accepted	1
Could be useful at technician but not higher levels	1
May not be applicable to federal government hiring system	1 + **1**
What it really means	1
Respondent confused educational certificate programs with professional certification	1

Generally negative (12); generally positive (6); positive with caveats (5); neither negative nor positive (4)

Table 4. *Summary of responses to four certification questions in the RCOOS CPOP/OSTO online survey. Responses from interviews and the industry surveys are also included and counted (in bold font).*

particular, this respondent would like to see training and certification options related to sensors (e.g., nutrient sensors) and technologies needed on observatories pursued, and thought that training and certification could be tied to professional societies.

3. CPOP survey (Appendix 2)

Two hundred two responses were received during the open online survey period. Thirty-eight of these came late in the open period from a single IP address, apparently associated with NDBC. However this influx of responses from a group of people that might be expected to have similar backgrounds and interests did not significantly change the distribution of responses compared to an analysis that was previously performed.

The first eight questions in the survey asked for information about the respondent:

- their current connection to the marine field (Figure 5)
- their age (Figure 6)
- their highest degree in an oceanography-related field (Figure 7)
- aspect of the oceanographic professions most closely matching their job or experience or interests (Table 5)
- type of organization with which they are presently affiliated (Table 6; Figure 8)
- whether they envision applying for a new job in the marine field in the foreseeable future (Figure 9)
- whether they currently possess, or have investigated pursuing, any professional certification (Figure 10)
- for supervisors, whether they consider professional certification in hiring, promoting, or contracting decisions (Figure 11)

These questions were included to measure the diversity of the sample population and so that we could sort the other responses according to various attributes of the respondents. The last two questions were an attempt to get information about the respondents' familiarity with professional certification in general.

The surveyed population included nearly equal numbers of supervisors (62) and non-supervisors (58) in non-education ocean science or technology (OST) jobs, and about half that number of educators (32), with the remainder

Answer	Response count
Hardware Technology[1]	65
Physics	53
Information Technology[2]	37
Biology	35
Environmental management	27
Geology	25
Chemistry	22
Fisheries	19
Policy	15
Meteorology	3
Data Analyst	3
Underwater acoustics	3
OOS	2
Engineering	2
GIS	2
Hydrography	2
Other	23
No Answer	1

Table 5. *Responses to the CPOP survey question: "What aspect of the oceanographic professions most closely matches your job experience or interests?" The first nine were offered as options in the survey, and respondents were allowed to choose more than one response. Respondents could also choose "Other" and fill in another answer. The seven other answers that were given by more than one respondent are listed next in the table. The remaining 23 answers were given by only one person each.*

[1] *equipment, instrumentation, platforms etc.*
[2] *including data management*

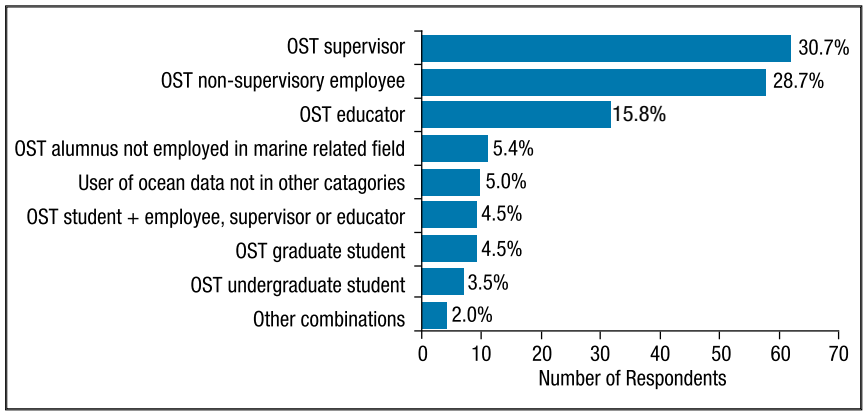

Figure 5. *CPOP survey question 1: "How would you describe your current connection to the marine field?" Respondents were allowed to choose more than one category. The survey gave "Alumnus of an ocean science or technology program" as a choice; here we have separated out those that gave this as their only answer from those that answered it in combination with something else. Two of the bars represent people who responded with more than one of the other categories. With these modifications, the numbers represented by the bar lengths sum to 202, the total number of respondents. The percentage of respondents in each category is written next to each bar.*

being OST students (25), and others not currently employed in the OST field (21). A few (4) had various other combined connections to the OST field, as shown in Figure 5. They ranged in age from 18 to 75 (Figure 6). Approximately one-third held an associate's or bachelor's degree, one-third a master's degree and one-third a doctoral degree (Figure 7). The

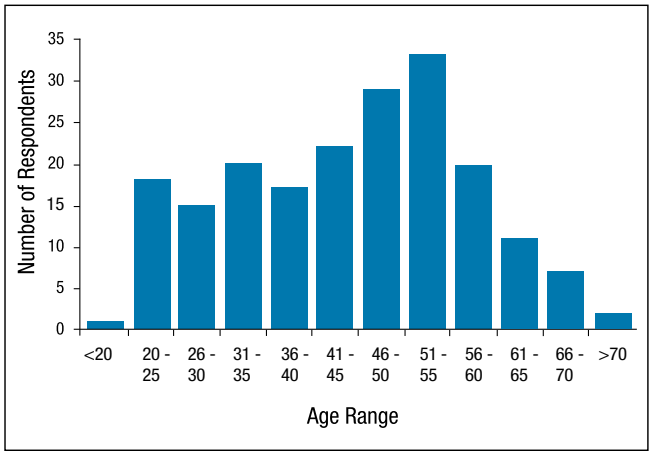

Figure 6. *Age of CPOP survey respondents. Seven people did not answer this question.*

Answer	Number of Respondents
Civilian government agency (local, state, or federal)	52
Civilian govt. & research or military	5
Civilian govt. & educational institution	4
Civilian govt. & business/industry	5
Business/industry	36
Business/industry & research or education	4
Educational institution	49
Education &/or NGO &/or research &/ or consulting &/or public education	7
Research institution	16
Military	10
Nongovernmental organization (NGO, community or activist-based organization)	7
Consulting	1
NGO & consulting	1
Consortia	1
Retired or unemployed	3
No answer	1
TOTAL	**202**

Table 6. *Answers to: "With what type of organization is your present primary affiliation?" In contrast to what is shown in Figure 8, those who chose multiple responses have been grouped so the total number of CPOP survey respondents (202) is enumerated.*

largest number of respondents was involved with hardware technology (65) and physical oceanography (53), but seven other interest areas were also mentioned by 15 or more respondents (Table 5). A nearly equal number of respondents were primarily affiliated with civilian government (66) and educational institutions (61), with somewhat fewer from industry (45) and research institutions (30), and even fewer from the military (11) and NGOs (9), as shown in Figure 8. Many respondents listed multiple primary affiliations (Table 6).

Questions nine through 11 asked the respondent to express whether they thought there should be a CPOP and why (Tables 7, 8). Thirty-six percent of respondents thought there should be a CPOP, but a higher percentage thought that there were reasons to have a CPOP. The most popular reasons to have a CPOP are that it would help identify qualified individuals by documenting experience and proficiency in a

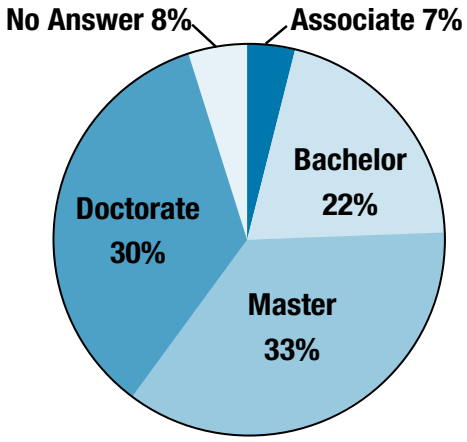

Figure 7. *Highest degree in an oceanography-related field received by the CPOP survey respondents.*

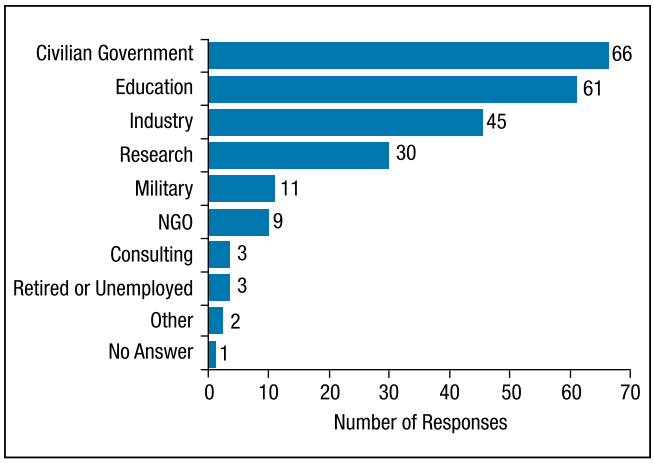

Figure 8. *Distribution by organizational affiliation of CPOP survey respondents. Numbers add up to more than 202 since some people listed more than one primary affiliation. Write-in answers to "Other" have been assigned to one or more of the categories shown, if appropriate.*

way that other measures do not (64 percent), and it would promote career-long learning through continuing professional development requirements (53 percent). Forty to 47 percent thought a CPOP would increase marketability and career opportunities, provide a personal sense of achievement for those that attain the credential, and help define a common body of knowledge in the field. Thirty-three to 38 percent thought a CPOP would improve ocean-related education and aid in development of the ocean-related workforce, increase confidence in oceanographic products/services, and increase visibility of marine-related professions (Tables 7, 8).

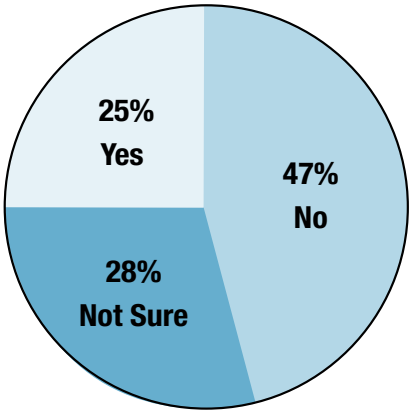

Figure 9. *Percent of 202 CPOP survey respondents who envision applying for a new job in the marine field in the foreseeable future.*

Identify qualified individuals by documenting experience and proficiency in a way that other measures do not	64
Promote career-long learning through continuing professional development requirements	53
Increase marketability and career opportunities	47
Define a common body of knowledge in the field	41
Provide a personal sense of achievement for those that attain the credential	40
Improve ocean-related education and aid in development of the ocean-related workforce	38
Increase confidence in oceanographic products/services	33
Increase visibility of marine-related professions	33
Do not think there should be a certification program for oceanographic professionals	17

Table 7. *CPOP survey respondents were asked to choose the reasons (listed in the table) for which they thought there should be a CPOP. They could choose more than one, and they could supply other reasons that were not listed. They were also given the choice: "I do not think there should be a certification program" (highlighted in gray). The percent of respondents choosing each answer is listed. Three people skipped this question; 14 people supplied comments.*

Of the 113 respondents familiar with professional certification (Figures 10 and 11), either because they have one, have investigated pursuing one, or are a supervisor who considers it in hiring, promoting, or contracting, 42 percent thought there should be a CPOP and nine percent thought there should not be one. Forty-two percent of those with less than a Ph.D. (84 respondents) thought there should be a CPOP; 17 percent thought there should not be one. Of people who might apply for a new job in the foreseeable future, 13 percent (of 107 respondents) thought there should not be a CPOP, while 34 percent thought there should be one (Table 9).

One respondent offered a new reason in support of certification: "Certification may promote recruitment of underrepresented groups (future workforce development) by 'validating' the field for those unfamiliar with ocean sciences as a career."

Some amplification of the first reason listed in Table 7 was supplied: "Raise the stature of non-University positions in oceanography," similarly expressed as "Allows an individual who is not in a scientific position to be certified in an aspect of oceanology giving

There is no way to define a certification program for a field as diverse as ocean science / technology.	28
Voluntary certification could lead to mandatory licensure in the future.	28
It would be time-consuming and expensive to set up and run a CPOP.	25
There is no identified problem which a CPOP would fix.	24
Certification would add an unnecessary hurdle to an individual's career path.	21
There is no acceptable way to objectively assess an individual's qualifications	19
There are already professional certification programs in existence which meet this need (such as: _____)	8
I think there should be a certification program for oceanographic professionals	36

Table 8. *CPOP survey respondents were asked to choose the reasons (listed in the table) for which they thought there should not be a CPOP. They could choose more than one, and in the next question they could supply other reasons that were not listed (Survey Monkey does not allow more than one fill-in-the-blank option for a given question). They were also given the choice: "I think there should be a certification program" (highlighted in gray). The percent of respondents choosing each answer is listed. Twenty people skipped this question; 46 people supplied comments. People listed the following as existing professional certifications that meet the need: IHO certification for hydrographers, Professional Engineer (listed by three people), educational degrees (listed by four people), Association for Computing Machinery (ACM) for computer scientists, American Petroleum Institute certifications, and IMarEST charter designation.*

them a credible voice with oceanographic concerns."

Seventeen percent of respondents thought there should not be a CPOP, but a slightly higher percentage than that had problems with some aspect of the idea. Twenty-eight percent of all respondents felt that there is no way to define a certification program for a field as diverse as ocean science / technology, and that voluntary certification could lead to mandatory licensure in the future. Nineteen to 25 percent of all respondents found a CPOP to be objectionable because of the time and expense to set up and run it; lack of an identified problem that a CPOP would fix; the addition of an unnecessary hurdle to an individual's career path, and the lack of an acceptable way to objectively assess an individual's qualifications. Only eight percent thought there were already professional certification programs in existence that met this need (Table 8).

Other reasons given why there should not be a CPOP included:

- Voluntary certification now could lead to mandatory certification or licensure in the future.
- Fees associated with acquiring and maintaining certification would be burdensome for individuals.
- It can become a barrier for minorities and entry-level personnel.
- Certification programs lend credibility to unethical consultants.
- The certification process demeans the scientist.
- National certification programs go against the grain of Capitalism.
- Certification would deepen the rift between oceanographers in academia and industry.
- It could lead to more litigation.
- A CPOP's requirements could not keep up with the rapid pace of technology advancement in the field.
- A CPOP could lead to a decrease in the quality of some academic programs if they try to teach to the certification requirements in order to "improve" their standings.

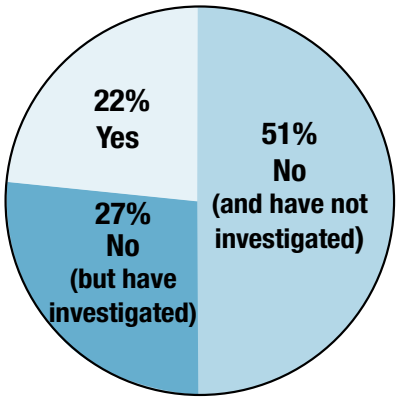

Figure 10. *Percent of 202 CPOP survey respondents who possess, or have investigated pursuing, any professional certification. Certifications that people listed include: CMarSci, QEP, Certified Fisheries Professional, various diving certifications, computing related certifications, Captain's or Master's license, Professional Engineer, licensed geologist, radiation safety/handling, CCM, Systems Engineering, GIS, CPR and Water Safety Instructor, hydrographer certification, Certified Enterprise Architect, CSEP, Chartered Chemist, Chartered Geologist, Project Management Professional. Several people also listed certificates, as opposed to certifications, here.*

The next question (12) asked how respondents would use a CPOP if it existed (Figure 12). Forty-four percent said they would consider applying for certification; 36 percent said they would consider using it in hiring and promotion decisions. Thirty-three

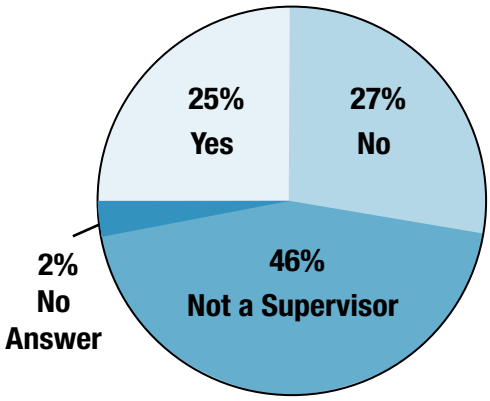

Figure 11. *Percent of 202 CPOP survey respondents who answered as shown to the question: "If you are in a supervisory or management position, do you consider professional certification in your hiring, promoting, or contracting decisions?"*

Criteria	Total	Pro CPOP # (%)	Anti CPOP # (%)	Would consider applying for CPOP # (%)
All respondents	202	72 (36)	34 (17)	89 (44)
< Ph.D.	84	34 (42)	14 (17)	44 (52)
Potential job seekers	107	36 (34)	14 (13)	59 (55)
Familiar with certification	113	48 (42)	10 (9)	64 (57)
Affiliated with industry	42	15 (36)	8 (19)	21 (50)

Table 9. *Numbers and percent of people meeting a certain criteria who answered questions in a given manner.*

Question	Yes	No	No Answer
Multi-level approach	146	47	9
Require basic knowledge across all ocean science and technology	124	70	8
Demonstrate high level of competency in one oceanographic discipline AND one technology specialty	86	102[1]	14

Table 10. *Summarizes the number of responses to CPOP survey questions concerning the desired structure of a CPOP: "Do you favor a multi-level approach for a certification program, such as outlined in the sample framework in the background document?", "Do you agree that successful applicants for certification should possess a certain basic level of knowledge across all aspects of ocean science and technology?", and "Do you agree that certified oceanographic professionals should demonstrate a high level of competency in at least one oceanographic discipline AND one ocean technology specialty?". Respondents were only allowed to choose one answer to each question.*

[1]*62 said competency in just a discipline would be adequate; 40 said competency in just a specialty would be adequate*

percent said they would use evidence of certification to promote their services. Twenty-five to 26 percent said they would look for certified individuals when seeking advice on oceanographic matters and would give more weight to information provided by certified individuals. Twenty-two percent said they would not make use of it. Twice as many people said they would consider applying for certification (89) as said they would not make use of a certification (45). The percentage of those who would consider applying for certification goes up if you consider just those who are going to or might apply for a new job in the next year (55 percent of 107 respondents), or those without a doctoral degree (52 percent of 84 respondents), as shown in Table 9. Of the 35 people who described themselves as ocean science or technology educators, 12 said they would consider making changes to courses or curricula to help students attain certification. The one additional use that surfaced in the comments was to use certification as a "carrot" or "something tangible to show for their efforts" that would serve as an incentive for employee retention.

The last six questions, with the exception of a final opportunity to add any other pertinent comments, focused on the respondents' opinions about what sort of structure a CPOP should take (Table 10), and who the target audience for certification should be (Tables 11, 12, 13). Survey respondents were 3:1 in favor of a multi-level approach to certification as described in the straw man framework. By a ratio of 7:4, they favored requiring a basic level of knowledge across all aspects of ocean science and technology as opposed to having expertise in just one aspect. By a slight majority, they favored allowing demonstration of expertise in just a scientific discipline (62 people) or just a technology specialty (40), as opposed to requiring both (86).

As far as the target audience for certification, 66 percent of respondents felt it should be aimed at practitioners with a bachelor's as their highest degree,

Answer	Response Count	Response Frequency
Associate	87	43%
Bachelor	133	66%
Master	98	49%
Doctorate	66	33%

Table 11. *Answers to the CPOP survey question: "Do you think certification should be aimed at individuals who hold the following as their highest degree in the marine field?" The answer chosen most frequently is highlighted in gray. Respondents were allowed to choose more than one answer, so response frequency sums to more than 100%.*

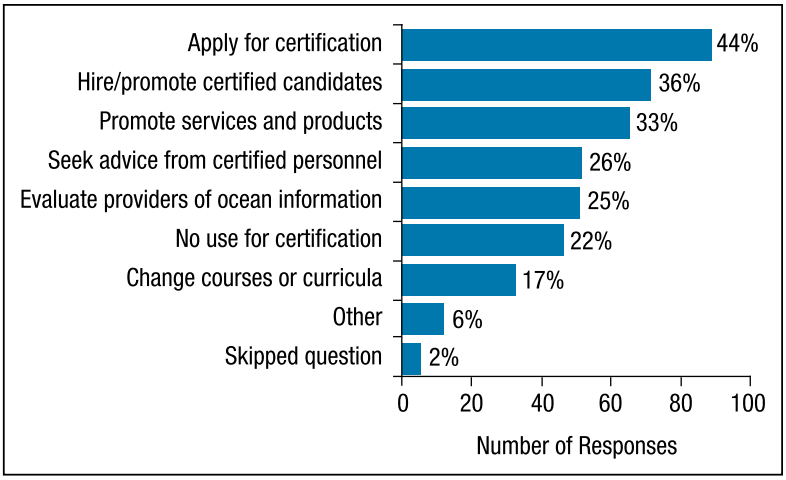

Figure 12. *CPOP survey respondents were asked how they would use certification and offered seven choices plus the option of filling in their answer (counted here as "other"). The exact wording of the choices can be seen in the survey (Appendix 2). Respondents were asked to check all options that applied, and the total counts are represented by the bar lengths. The percentage of the 202 respondents that picked each option is written beside each bar.*

49 percent thought it should be geared to those with a master's as their terminal degree, 43 percent favored certification for those with only associate's degrees, and only 33 percent thought certification should be aimed at individuals with a doctorate in the field (Table 11). Note that respondents could choose more than one type of terminal degree.

When asked which ocean career "tracks" would benefit most from certification, 61 percent chose operational oceanographer / forecaster and 57 percent said technician. Other tracks that were frequently selected include consultant and environmental / resource manager with 42 percent each, research scientist (37 percent), educator (28 percent), and computer scientist (20 percent), as outlined in Table 12. Eighty-five respondents listed specific oceanographic disciplines or technology specialties, or combinations thereof, for which they thought certification is especially needed (Table 13). Technicians, ocean forecasters, and physical and chemical oceanographers top this list. Those who chose operational oceanographer / forecaster and technician are distributed by organizational affiliation (Figures 13, 14) similarly to the surveyed population as a whole (Figure 8). A slightly larger percentage of people choosing these two occupations as targets for certification are affiliated with a civilian government organization (probably reflecting the input from NDBC), with corresponding reduction in those affiliated with research and/or educational institutions and/or NGOs, compared with the survey population as a whole.

Answer Options	Response Count	Response Frequency
Computer Scientist	41	20%
Consultant	85	42%
Educator	56	28%
Environmental/Resource Manager	84	42%
Operational Oceanographer / Forecaster	124	61%
Research Scientist	74	37%
Technician	115	57%
None	25	12%
Other (please specify)	17	7%
Skipped question	7	3%

Table 12. *Answers to the CPOP survey question: "For which tracks (such as suggested in the sample framework) do you think certification would be useful?" Respondents were allowed to choose more than one answer, so response frequency sums to more than 100%. The answers chosen most and second to most frequently are highlighted in dark and light gray, respectively. Other tracks listed by respondents included: numerical modeling, operational oceanography technicians, ROV/AUV operator, data managers, support staff for ocean-related committees, ocean policy, and ocean sensor metrologist. Three people listed engineers.*

Forty-two comments were received in response to the open-ended request for other comments at the end of the survey. Of these, nine were generally positive in regard to a CPOP, including this one:

> I think this is a great idea. If it's used in other sciences such as Meteorology, why not also do it for Oceanography too? I have a Bachelor's in Marine Science and a Master's in Meteorology, and while I have looked into certification for weather, I would also like to get one in Oceanography.

Thirteen of the final comments were generally negative, including:

> Terrible idea! Just provides an excuse for sub-standard oceanographic education/training (e.g., We don't have to worry about weeding out bad students; their inability to get certified will do that for us later, after they've 'graduated'....).

Twenty of the comments were neutral or undecided, including:

> I'm not convinced this is a good idea, but I'm also not convinced it is a bad idea.

Only two survey comments mentioned possible effects of certification on minority participation, and

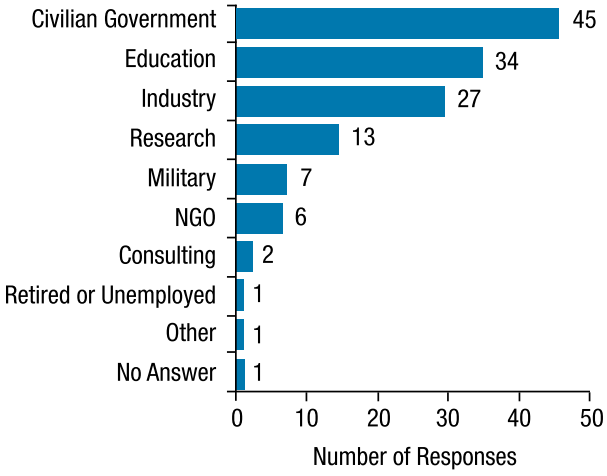

Figure 13. *Distribution by organizational affiliation of CPOP survey respondents who chose operational oceanographer / forecaster as a target audience for certification. This "track" was chosen 124 times, but since some people listed more than one primary affiliation, the numbers represented by the bars add up to 137. Write-in answers to "Other" have been assigned to one or more of the categories shown, if appropriate.*

they had diametrically opposed views:

> Certification may promote recruitment of under-represented groups by 'validating' the field for those unfamiliar with ocean sciences as a career.

> I think that the concept has merit, but I am concerned that it can become a barrier for minorities and entry-level personnel.

Several comments concerned whether there was really a need for certification:

> The key question in assessing the merits of this is "who wants this certification?" If it is individuals who want it, the primary use will be to inflate their capabilities. If institutions want it and will use it, there is merit in this effort.

> Any certification effort should be aligned with clearly defined need from the work place.

> Make sure that there is strong buy-in from employers before proceeding.

> Our community is poised for growth in operational oceanography driven by societal needs. Society will need to have tangible reason to trust our operational results a priori, and certification in key areas can help engender that trust.

F. Workshops

1. Orlando, Florida (March 2008)

In conjunction with the OSTO project, we held a brief open workshop at the Ocean Sciences Meeting in Orlando on March 7, 2008. Thirty-three people

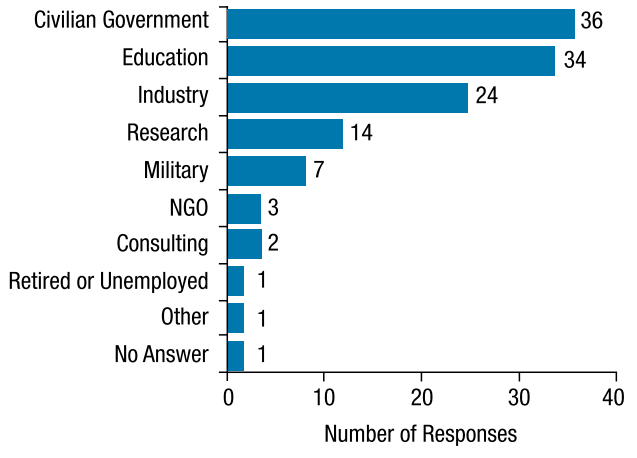

Figure 14. *Distribution by organizational affiliation of CPOP survey respondents who chose technician as a target audience for certification. This "track" was chosen 115 times, but since some people listed more than one primary affiliation, the numbers represented by the bars add up to 123. Write-in answers to "Other" have been assigned to one or more of the categories shown, if appropriate.*

• Marine science technician (10); Instrument technician (5); Ocean observing system technicians (3)
• Numerical modeling/forecasting (13)
• Oceanographer – Physical (12) + ▪ Phys. Ocean. & computer programming ▪ Phys. Ocean. & HF radar technology ▪ Phys. Ocean. & numerical modeling ▪ Phys. Ocean. & electronics – Chemical (13) – Biological (6) + ▪ Biol. Ocean. & modeling ▪ Biol. Ocean. & ecosystems – Geological (5) – Geophysical (2) – Archaeological (2) – Biochemical (1)
• Engineering (8)
• Acoustics (6) + – Acoustics & electronics & data collection
• IT / marine computers and systems operations (6)
• Operational oceanography (5)
• Remote sensing (5)
• Deck safety / deck ops (4)
• Electronics (4)
• Data QA/QC (4)
• GIS (3) + – GIS & programming & visualization
• Education (3)
• Environmental impact studies (3)
• Data management (3)
• Experimental design (2)
• Consultants (2)
• Optical oceanography (2)
• Hydrography (2)
• Oceanography + computer science, economics, or policy
• Oceanography + fiber optics, underwater imaging, or sensor technology
• AUVs/ROVs, computational programming, taxonomy, meteorology, benthic habitat survey methods, survey tech, telecommunications, marine policy, oceanographic metrology- 1 each

Table 13. *In answer to CPOP survey question 18, 85 people listed specific oceanographic disciplines or technology specialties, or combinations thereof, for which they thought certification is especially needed. Answers given by more than one respondent are indicated by the number of like responses in parentheses following the answer. A few comments could not be characterized in terms similar to the others, so are not included here.*

attended a 1¼-hour workshop entitled "A Discussion on the Current and Future Needs of the Ocean Science, Technology, and Operations Workforce." Ideally, the workshop would have followed the OSTO workforce oral conference session, but due to circumstances beyond our control, the workshop was scheduled in the lunchtime slot before the oral session. We provided a number of handouts concerning the OSTO and CPOP projects and we had lively discussion concerning certification, continuing education, and the workforce needed for operational oceanography among other things. One attendee, Frank Bub of the Naval Oceanographic Office, thought the critical considerations for defining an activity to be operational oceanography were whether it was aimed at a customer and whether it was time-critical (Bub, 2008). We were able to follow up with a number of the attendees of this meeting via interviews, surveys, and workshop attendance.

2. Monterey, California (November 2008)

The OSTO and CPOP projects jointly sponsored an invitation-only workshop (Appendix 3) held in Monterey from November 10-12, 2008 (Marine Advanced Technology Education Center, 2008). Forty-four people from across the United States, plus one from Canada, representing government, industry, academia, public education, research, ocean observing systems, workforce and policy studies, and professional societies and certification programs were present (Figures 15 and 16). While we were able to achieve good geographic representation and attendees came from a variety of types of organizations, we were not as successful as we would have hoped in securing attendance from small ocean instrument companies, workforce studies experts, and policy makers. There were a number of last minute cancellations in the former category, attesting to the difficulty of sparing an individual from a small company for even a few days. Our limited personal connections in the latter two categories may have contributed to the lower invitation acceptance rate in those areas.

The half-day session on professional certification included a CPOP project overview with results to date by Leslie Rosenfeld; a presentation by Jan van Smirren of Fugro Global Environmental & Ocean Sciences (GEOS) that included his company's views on certification; and overviews of hydrography (Jerry Mills, ACSM/THSOA Certification Board) and GIS (Deidre Sullivan) certifications. A number of suggestions were made in response to Rosenfeld's presentation. These were all taken for action by the CPOP PIs and relevant results are incorporated into other parts of this report. Information presented concerning the certification programs is incorporated into section III.B of this report. Mel Briscoe, Jerry Boatman, and Tom Wiener, representing TOS, MTS and IEEE respectively, made brief presentations. The IEEE process (Figure 3), presented by Wiener, for deciding whether and how to proceed with a new certification program is discussed briefly in Section

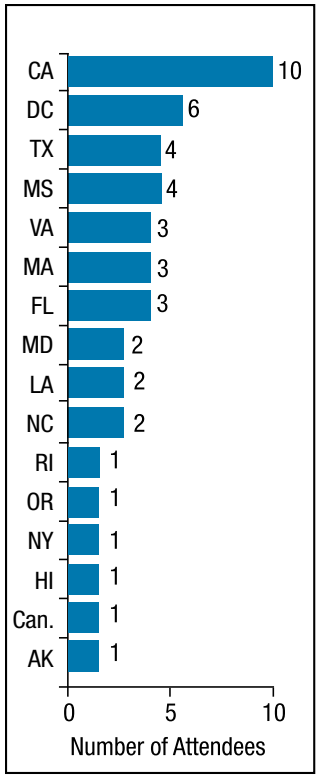

Figure 15. *Distribution of November 2008 workshop attendees by state.*

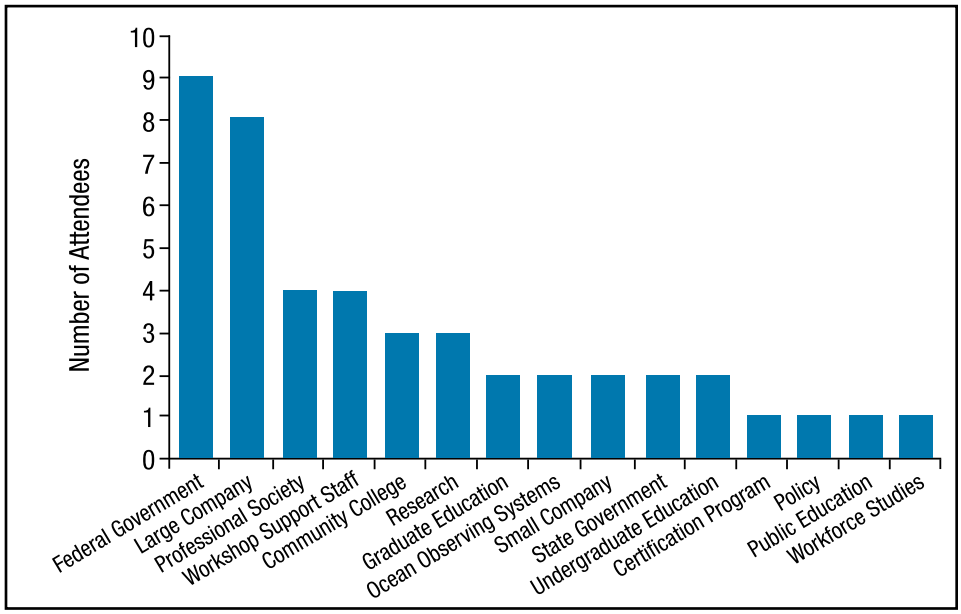

Figure 16. *Distribution of November 2008 workshop attendees by type of organization. Note that some attendees are associated with more than one category of organization, but they are categorized here by the organization or expertise for which they were primarily invited to the workshop.*

III.B.4. Briscoe presented a draft MOA (Appendix 6) among TOS, MTS, and AMS. The next morning there was a breakout session on certification with about half the workshop attendees participating in a lively discussion. Further discussion among all the remaining attendees followed. A post-workshop survey was sent to all attendees.

Briscoe stated that there had been much discussion in the past about professional certification for oceanographers, but it had not really led to anything. Therefore, he hoped to move the issue forward by presenting a draft MOA agreed to by AMS, MTS, TOS, and under review by IEEE/OES, for the purpose of collaborating on a joint project on professional certification for oceanographers. The stated plan was for the final MOA to include recommendations and insights from the workshop. The final MOA, dated 15 December 2008 and signed by TOS and AMS to date, is included in this report as Appendix 6. It included the assignment of various roles to the different professional societies, and identified a team tasked to follow up with the proposal. A schedule with decision points and roll-out dates was presented, but Briscoe also stated that they were waiting to decide what to be done and how fast they could move ahead. However, he emphasized that the ball is rolling and they are serious about making something happen.

Briscoe's presentation sparked much debate; several participants were upset because it appeared that the establishment of a certification program was a certainty, whereas others interpreted his remarks to mean that the professional societies were going to pursue more study to find out if it was needed. The next morning, during the certification breakout session attended by 22 people (see sidebar, right), Briscoe backed off his statement from the previous day that had made it sound like the professional societies were going ahead no matter what. He agreed that they were going to proceed with investigating certification. Some of the industry representatives, who initially saw certification as an "us vs. them" issue, gradually came around to Briscoe's toned-down position after

Report from the Professional Certification Breakout Group

Primary benefits of certification:

- Helps the educational system put value on non-academic career paths
- Increases visibility of the field and opportunities in it
- Professionalizes OSTO careers/occupations

Next steps (undetermined as to what groups will do each of these):

- Can't have a one-size fits all certification. Need to identify relevant occupations and determine which occupations should be considered for certification. For example, ocean observing system technicians, data collection technicians, operational ocean forecaster, "oceanographic product provider." Need to narrowly and specifically define.
- Determine what are the core competencies (aka "measurable moments") for these occupations and who defines them. Need to involve the appropriate sectors (industry, government etc) in this discussion.
- Identify standards for forecasts, products, services.
- Areas with liability issues are more likely to want some type of some assurance that the product and service providers they're relying on are competent (e.g., data analysts in OOS or data products in OOS). There needs to be a decision made on whether this is through the certification of a profession or the evaluation of a product and/or service.

Things to consider:

- Certification is voluntary.
- There needs to be a process by which organizations (e.g. industry, Navy, etc.) have a vote at the "stop" points in the certification process if they're going to be involved in determining the competencies, tracks, etc.
- Need to recognize that different sectors (government, industry, academics) may have different needs/uses for certification

Question #	Strongly Agree	Agree	Disagree[1]	Strongly Disagree	Don't know enough[2]	Doesn't make sense	No answer[3]
1	9	9	1	1	4	0	2
2	12	7	1	1	3	0	2
3	9	10	2	0	3	0	2

Table 14. *Number of November 2008 workshop participants who responded with given level of agreement to each of three questions (see text). Twenty-six of the 45 who attended completed at least some portion of the survey.*

[1] *One individual disagreed with all three statements.*

[2] *Three individuals said they did not know enough about the topic to offer an opinion on all of the three statements.*

[3] *Same two individuals did not respond to all three statements*

Industry Case Study: Fugro GEOS

Fugro GEOS is a major provider of physical oceanographic services to industry and government. It characterizes, monitors, analyzes, hindcasts, nowcasts, and forecasts variables such as wind, atmospheric pressure, air temperature, ocean waves, currents, tides, salinity, and temperature, and structural parameters such as motion and strain. It has up to 500 employees in physical oceanography or closely related fields, distributed internationally, who potentially would be candidates for certification. The employees range from 0-25 in years of experience and their highest degrees include bachelor's, master's, and doctoral degrees. Currently, professional certification is not a primary factor in Fugro GEOS's recruitment decisions, but it recognizes the value of certification in terms of training, career development, staff retention, marketing, and fair competition. The management of Fugro GEOS was very active in setting up the certification process in the UK. (CMarSci program is described in Section III.B.1.iii of this report.) The staff perception of certification is positive: ten employees hold the CMarSci credential and another 25 percent are IMarEST members of one type or another who may be working towards chartered status. The Fugro GEOS in-house Graduate Training Program is linked into the CMarSci requirements. The company is trying to get their non-Asian, non-U.S. staff certified. One of the issues it has encountered in regard to professional certification is that the somewhat vague definitions of the credential requirements have lead to confusion, but even so, the requirements have made training more balanced. In particular, the quality of training material has improved, and learning objectives and assessment methods have greatly improved, which links to competency recording.

Preparing training materials is very time-consuming, but Fugro GEOS has found that graduate training programs and certification are a primary factor in staff retention. Fugro GEOS would like to see certification be a prerequisite for contracts/grants in government and private industry. Its hope is that the growth of professional certification in this field will also lead to the development of training systems akin to the Cooperative Program for Operational Meteorology, Education and Training (COMET, www.comet.ucar.edu), to reduce the burden on individual groups of preparing their own materials. Fugro GEOS believes that certification requirements and training materials should include quality assurance and project management.

— van Smirren, 2009

it was agreed that industry, Navy, and other interested parties would get a vote in the process of whether and how to proceed with a program.

Two other points were made during the general discussion near the end of workshop. It was clear that the target level for certification was below the doctoral level; that is, at the associate's to master's level. Also, there is a need to build credibility for certifications in conjunction with universities and community colleges. Some felt that should a certification program be instituted, the natural place to start feeding the requirements into the pipeline is through community colleges.

A post-workshop survey was placed on Survey Monkey in early January 2009 and completed by 26 of the workshop attendees over the course of the following month. The survey included statements based on the findings and recommendations made during the November workshop. Respondents were asked to indicate their level of agreement or disagreement by choosing either: Strongly agree, Agree, Disagree, Strongly disagree, I don't know enough about the topic to respond, or This statement does not make sense to me. They could also add additional comments at the end.

Quantitative results for the three statements that pertained specifically to certification are reported in Table 14. The respondents overwhelmingly agreed with each of the statements below. Comments are listed below each statement.

i. OSTO-related professional societies should pursue a certification decision process similar to that applied by IEEE to determine whether a certification program for OSTO professions is needed and feasible. This process should include a number of decision points at which a certification effort could be deemed unnecessary or unfeasible. All concerned parties should be involved in the decision process.

- I am not sure this will be valuable.
- The process described is a sound one. However, I haven't heard many in industry, academia or government asking for such. Believe that NOAA is probably the exception.
- From listening to the discussions at the workshop, and from my experience with certification programs, I would tend to avoid taking this direction. The track record of certification, the dynamism in today's workforce requirements, the [sheer] number of existing "certificates" that already exist in various skill set areas relating to the OSTO workforce makes this certificate option a candidate for an unnecessary complications. Functionally and operationally it would be a bear.

- I favored this idea initially, but if it would add extra costs (and annual fees) to employees or employers, then this might be prohibitive. There are so many areas of expertise that it might be difficult to administer, unless there were many categories of certification.
- This whole section represents your strongest points. I absolutely agree that certification is necessary for all the reasons so stated in this survey.
- I think a professional certification for OCEANOGRAPHERS is the way to go.

ii. Certification decision processes should focus on identifying for which OSTO occupations, if any, certification is relevant and likely to lead to significant benefits for employees, employers, end users of OSTO products, or others.

- Same feelings on this as were expressed in number *i* above. (See comment in third bullet above.)
- Beware of little niches... for example, somebody might want to certify an ROV [remotely-operated vehicle] operator which is not at the same level of a Professional Certification for Oceanographers.

iii. The benefits of existing professional certification programs in fields similar to OSTO should be identified. This effort should address both quantitative and qualitative assessments of the benefits to employees, employers, educators, customers, and others.

- There is expense in such a process. If an agency such as NOAA is willing to call for the process, then the professional societies are probably the right place to start a general certification. Note: many in industry and government do a certification that meets their own specific needs, and aren't overly supportive of a generic certification.
- You could expend so much time and energy on this that could, in my view, be far better spent on all the other more direct items mentioned in A, B, and C. (A, B, and C are other sections of the survey having to do with the OSTO workforce.)
- No need to reinvent the wheel.

3. Monterey, California (March 2009)

During March 19-20, 2009, the OSTO project hosted an invitation-only workshop in Monterey, with 12 invited and two staff participants to define the job functions and needed knowledge and skills for physical science *in situ* OOS technicians. In advance of this workshop, we developed a draft of proposed job functions for physical science OOS technicians and included it in an online survey for comment. Seventy-nine people completed the survey, and the collected responses were used to generate a revised list of job functions that became the basis for the workshop discussions. Note that college was just one of many venues where the survey respondents said they received their physical science technical training, and it was outnumbered by on-the-job training in their responses (Figure 17).

During the workshop, the participant panel agreed to rename this occupation as "Oceanographic Instrumentation Technician," and created the following occupational definition: "Oceanographic instrumentation technicians are responsible for the collection of oceanic and marine atmospheric observations. They collect reliable, quality data using *in situ* ocean observing instrumentation to meet user needs for government, industry, academia, and the public." An overview of the job functions and tasks of oceanographic instrumentation technicians will be included in the forthcoming report from the OSTO project.

This survey and workshop were sponsored by the OSTO project to aid in the development of the OOS technician workforce. However, the findings may prove valuable in defining a body of knowledge for

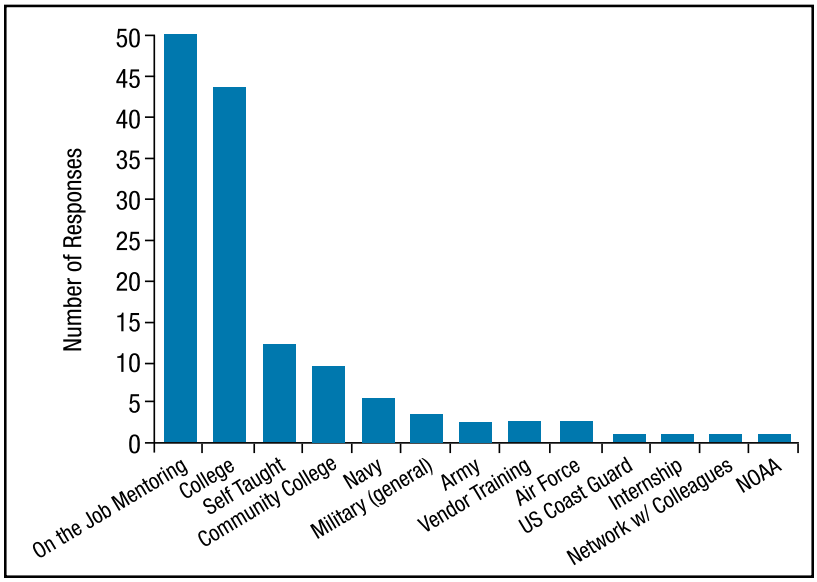

Figure 17. *Distribution of responses from 77 physical science ocean observing system technicians to the question "Where did you obtain your physical science technical training?" Respondents could choose more than one response.*

marine technicians, should some organization(s) wish to proceed with developing a professional certification focused on this occupation.

Another small workshop in September 2009 focused on defining the the job functions and needed knowledge and skills for ocean forecasters.

G. Ocean Observing / Operational Oceanography Degree / Certificate Programs

While this project did not undertake to study whether oceanography, marine science, or marine technology curricula in this country should be standardized or accredited in some way, we felt it would be useful to summarize here what we learned about the emerging trend in educational programs emphasizing ocean observing or operational oceanography, as the curricula might contribute to the development of the body of knowledge required for certification. Note that IMarEST in the UK, which offers the CMarSci credential, also accredits university courses of study, as well as accrediting training programs for large companies, including the Shell MetOcean course. It is not our intent to offer a critique of the below programs or include their detailed structure and courses, but rather to make readers aware of them.

1. **Rutgers University**

   One of the recommendations from a 1999 community-wide workshop titled "Challenges and Promise of Designing and Implementing an Ocean Observing System for U.S. Coastal Waters" was to train a new generation of support staff to operate the networks. The Rutgers program is a response to this need for "a new type of oceanographer, one trained in the sustained operation of advanced observing technologies..... Oceanographers with technical experience in engineering or computer science [were] the missing segment of the training spectrum." (Glenn et al., 2005)

   Rutgers University offers a master's degree, with thesis requirement, in Operational Oceanography (Rutgers University, 2009). The program, intended to be completed in two to three years, takes advantage of an active coastal ocean observatory. The goal is to produce "specialists familiar with individual sensors and systems, the data processing, the assimilation of the data into models, and interpretation of the results leading to a better understanding of the present and predicted state of the coastal ocean." (Glenn et al., 2005) Only a couple of students had graduated from this program as of fall 2008. The main impediment to larger student numbers is obtaining funding for master's as opposed to doctoral students. New Jersey state funding can only be used for students intending to pursue a doctoral degree.

2. **Texas A&M University (TAMU)**

   TAMU is offering a certificate in ocean observing systems (TAMOOS). DiMarco et al. (2006), in discussing professional certification, state that they believe that "adoption of a certificate will establish a national standard knowledge base that is relevant and essential to the developing ocean science and technology career fields." At the 2008 OSTO workshop in Monterey, Lisa Campbell, a professor in TAMU's Department of Oceanography stated that TAMU's goal is to train the next generation of ocean professionals in ocean data collection, data management, and production and distribution of products and services (Campbell, 2008). This is not a stand-alone certificate program; it is designed to be completed in combination with an M.S. in Geoscience (DiMarco et al. 2006). It involves a combination of scientific and technical training, and, as with Rutgers, takes advantage of a locally-operated coastal ocean observing system. Areas of concentration include ocean instrumentation, data processing, numerical modeling, GIS, and meteorology. Training is focused on ocean data collection, data management, and production and distribution of products and services, as opposed to research. The first certificate was awarded in 2007, and they have had at least three graduates. In November 2008, there were seven students in the program. These are non-thesis students, so they do not receive financial support.

3. **University of Southern Mississippi (USM)**

   The USM Gulf Coast website (www.usm.edu/gulfcoast/marine) in late February 2009 stated:

   > Beginning in fall 2007, The University of Southern Mississippi will offer the only Bachelor of Science in Marine Science degree program in the state of Mississippi. The Bachelor of Science in Marine Science offered on the Mississippi Gulf Coast will educate students in the multi-disciplinary field of marine science and provide a basic understanding of the underlying principles and processes of the ocean. The program will also prepare students for the post-graduate studies in biological, chemical, geological, and physical oceanography at The University of Southern Mississippi or other institutions of higher learning. The program is based on required and elective courses that are broadly applicable across the discipline of marine science. The program is designed to meet the marine science and oceanography coastal observing community and the growing educational needs of the United States Navy.

   We have no information as to the number of students enrolled in this program. We mention this, and not other undergraduate degree programs in marine science, because it is new and it has a stated goal of supporting the coastal observing community and the Navy.

4. **Center for Coastal Margin Observation and Prediction (CMOP)**

   CMOP is a consortium of the Oregon Health and Science University, Oregon State University (OSU) and University of Washington Applied Physics Laboratory. According to Jack Barth, professor of physical oceanography at OSU, CMOP (or perhaps just OSU initially) hopes to start an ocean observing education program similar to those at Rutgers and TAMU (Barth, 2007). They are considering a one-year certificate program that would fall between the bachelor's and master's degree levels. They are at least a couple of years away from formally launching such a program, but they could start with a couple of courses at OSU sooner than that. They are very interested to learn the results of the CPOP and OSTO efforts.

5. **University of Hawaii (UH)**

   UH is considering offering a non-thesis master's degree in applied or operational oceanography. According to Mark Merrifield of UH's Department of Oceanography, they have had some planning sessions to design such a program, but as of early 2007, no official steps had been taken (Merrifield, 2007). We are not aware if any progress has been made since then.

H. Outreach

In addition to the meetings, interviews, surveys, and workshops described above, information about the CPOP project was distributed via the project website (www.marinetech.org/cpop), an article published in the Winter 2007 edition of the ORION newsletter, and presentations at national and regional meetings. Rosenfeld presented an overview of the CPOP project at the Eastern Pacific Ocean Conference at Leavenworth, Washington in September 2007. Lani Clough, a MATE employee, gave a CPOP talk at the SAMOS workshop in Seattle in June 2008. Sullivan briefed a meeting of UNOLS research vessel managers in Monterey on November 8, 2007.

A special session entitled "The Ocean Science, Technology, and Operations Workforce" was held on March 7, 2008 at the Ocean Sciences Meeting in Orlando. The call for talks encouraged presentations on certification, among other topics. Rosenfeld presented a talk on the CPOP project (Rosenfeld et al., 2008) and Bev MacKenzie presented a talk on the CMarSci credential (MacKenzie and Wainwright, 2008).

We also held a meeting in Washington, D.C. on April 27, 2007 to inform key federal government employees about the CPOP and OSTO projects, and seek their feedback.[4]

On April 30, 2007, the project PIs met with Brad Wiggins, industry lead for Biotechnology, Homeland Defense, and Geospatial Business Relations Group, from the Employment and Training Administration (ETA) of the DOL to share our study and learn more about the ETA's priorities, how they determine their high growth job areas, and their process and priorities for funding new projects. The U.S. DOL is responsible for keeping track

Relevant Occupational Titles and Standard Occupational Classification (SOC) Codes

A075 GEOLOGISTS AND GEODESISTS

Include workers in the following occupations:

Geologists—-Study the composition, structure, and history of the earth's crust. Examine rocks, minerals, and fossil remains to identify and determine sequence of processes affecting development of the earth. Apply knowledge of chemistry, physics, biology, and mathematics to explain these phenomena and to help locate mineral and petroleum deposits and underground water resources. Prepare geologic reports and maps, interpret data and recommend further study or action. May be designated according to specialty as: Petroleum Geologist, Mineralogist, Petrologist, Photogeologist, Geophysical Prospector, Oceanographer, etc.

A074 ATMOSPHERIC AND SPACE SCIENTISTS

Exclude Physicists and Astronomers (A069).

Analyze and interpret meteorological data gathered by surface and upper-air stations, satellites, and radar to prepare reports and forecasts for public and private users. Issue weather information to news media. Prepare special forecasts and briefings for those involved in air and sea transportation, agriculture, fire prevention and air-pollution control. Issue hurricane and severe storm warnings. Include Meteorologists.

— U.S. Department of Labor Bureau of Labor Statistics, 2000

[4]Attendees at the OSTO/CPOP meeting in Washington D.C. 4/27/07 were Sue Cook, Jerry Miller, Dick West, and Reggie Beach (Consortium for Oceanographic Research and Education); Leslie Peart (Joint Oceanographic Institutions); Deidre Sullivan (MATE); Barbara Wallace (MMS); Blanch Meeson (National Aeronautics and Space Administration); Carrie McDougall, Marlene Kaplan, Peter Stone, Marie Colton, Timi Vann, Peg Steffin, Brian Boettcher, and Terri Wlaschin (NOAA); Tom Murphree, Leslie Rosenfeld (Naval Postgraduate School); Lisa Rom, David Campbell, Liz Teles, Don Elfin (National Science Foundation); Joan Cleveland (Office of Naval Research); Mel Briscoe, Rick Spinrad (TOS); Bob Ridkey (U.S. Geological Survey).

of the approximately 10 million employers and 100 million plus workers in the United States However, very few Standard Occupational Classification (SOC) codes (used to describe occupational titles) are assigned strictly to marine activities. The maritime sector (Water Transportation Workers) is the only marine/ocean sector that is well defined. Most marine-related occupations are grouped with land-based occupations that make it difficult to understand the nature of marine occupations based upon DOL information alone. For example, Oceanographers are grouped together with Geologists (see sidebar, previous page). So the number of Oceanographers and specific information on their workforce trends can not be determined from DOL data. However, a few related occupations, such as Atmospheric Scientists, do have a SOC code assigned to them.

Establishing a new SOC code is a lengthy process and criteria to establish a new code largely depend on whether the size of the occupation is large enough to find a statistically significant number of workers in a survey of household or business establishments. There appears to be some resistance to adding new titles because it would make it harder to understand the change in the size of an occupational cluster, such as Geologists and Geodesists, if component occupations were continually added or deleted over time.

During our meeting with Wiggins, we talked a bit about the *High Growth Job Training Initiative*, a strategic effort to prepare workers to take advantage of new and increasing job opportunities in high growth, high demand and economically vital sectors of the American economy. *The High Growth Job Training Initiative* targets worker training and career development resources toward helping workers gain the skills they need to build successful careers in these and other growing industries. Much of the ETA's work and funding is focused around 14 existing or emerging sectors that are being transformed by technology and innovation requiring new skills sets for workers (U.S. Department of Labor Employment and Training Administration, 2009a).

Within the 14 high growth sectors defined by the ETA, geospatial technologies is the one most closely aligned with oceanographic operations and ocean observing systems, hence our choice of Wiggins as the most appropriate person to meet with at DOL. He had not heard of ocean observing systems and we spent a bit of time making the connection between OOS, Earth Observing Systems, the NWS, and geospatial technologies. Although this discussion was peripheral to certification, it was important to share information and understand how the DOL might recognize and support the development of the ocean workforce. The ETA does engage in apprenticeship efforts such as the Geospatial Technology Apprenticeship Program for GIS that could serve as a stepping stone to certification (U.S. Department of Labor Employment and Training Administration, 2009b). Many of the activities that Wiggins described appeared to be a business/industry-centric approach to workforce development that relies heavily on partnerships with industry. It was clear to us that if the ocean community were to take advantage of the ETA funding, it would need to fit solidly within one of the 14 initiatives and build strong relations with industry. In seeking broad support for certification, including funds for training and potentially apprenticeship programs, discussions should continue with the ETA. It was our impression that the ETA would be more likely to be supportive of developing and funding more entry-level positions (such as those that could be attained with a two-year degree) than more advanced level positions.

IV. Discussion

During the course of this study, we interacted with about 621 persons with an interest in the ocean science, technology, operations, and policy arenas (Table 15). Most of them had not previously given much thought to the idea of professional certification for oceanographic occupations. Many (up to half) were not familiar with professional certification programs in general, and certainly not in other environmental professions. Many people confused professional certification programs with educational certificate programs, some even after reading the background documents distributed as part of this project or attending one of the workshops.

Among the 330 people we surveyed and interviewed, just over half (52 percent) were undecided or did not express an opinion for or against a CPOP (Table 15). Among those that did express a definite opinion, more than twice as many are pro as are con (110 vs. 49). Based on the CPOP survey responses alone (Table 9), the proportion of people supporting a certification program increased slightly, from 36 to 42 percent, among the population with less than a doctorate as their terminal degree, or who have previous experience with professional certification. Interestingly, a higher percentage (44 percent) would consider applying for certification if a CPOP existed, than said they think there should be a CPOP (36 percent). The percentage that would consider applying for certification also increases among those with less than a Ph.D. (to 52 percent), those familiar with certification (to 57 percent), and for those who think they might seek a new job in the OST field in the foreseeable future (to 55 percent). Seventeen percent of the survey respondents said they thought there should not be a CPOP.

While we can report the numbers of people in various categories who expressed this or that opinion in regard to a CPOP, the numbers do not capture the strength of the sentiment expressed, and so do not necessarily answer a question asked by many people we heard from. One put it this way: "The key question in assessing the merits of this is, 'Who wants this certification?'" This respondent felt that "If it is individuals who want it, the primary use will be to inflate their capabilities. If institutions want it and will use it, there is merit in this effort." Others echoed at least part of that sentiment saying: "Any certification effort should be aligned with clearly defined need from the work place" and "Make sure that there is strong buy-in from employers before proceeding." The November 2008 workshop breakout group cautioned that there is a need to recognize that different sectors (government, industry, academia) may have different needs / uses for certification.

Certification for Ecological Engineering?

Matlock et al. propose guidelines for curriculum development and professional certification in ecological engineering in the United States:

> Ecological engineering is the design discipline for ecology, including but not limited to ecosystem restoration and conservation biology. The field of ecological engineering is broadly defined, without a clearly recognized core body of knowledge, and is not clearly identified as a professional specialization in engineering certification programs…. Developing and protecting the credibility of ecological engineering as a profession requires clear definition of the body of knowledge a practicing ecological engineer must master prior to being certified. (Matlock et al., 2001)

Although certification for oceanographers has some similarities to that for ecological engineers, the latter profession has some added difficulties:

> The difficulty is in the use of the term 'engineer.' In the US, engineers must be certified by a professional board of licensure in order to practice. There is currently no certification process for ecological engineers. Professional certification is required if ecological engineering is to be a recognized engineering profession. The process for creating certification for any type of professional engineer (PE) is meticulous, time consuming, expensive, and requires a great deal of planning before the legal process of establishing certification can begin. (Matlock et al., 2001)

As of the writing of this report, it does not appear that a professional certification for ecological engineering is in place in this country.

To date, the strongest proponents for a CPOP that we have encountered are associated with TOS, NOAA, Fugro GEOS, and SAIC, Inc., a scientific, engineering, and technology applications company.

A. Arguments for Certification

The most popular reasons cited in support of creation of a CPOP are that it would help identify qualified individuals by documenting experience and proficiency in a way that other measures do not, and that it would pro-

mote career-long learning through continuing professional development requirements. However, at least one-third of the CPOP survey respondents agreed that each of the statements listed were reasons to have a CPOP (Table 7). The workshop breakout group and several survey respondents said that a CPOP would professionalize or raise the stature of OSTO careers or occupations outside of scientific or university positions. Several interviewees saw professional certification as a way to put scientists and some other types of employees on a par with engineers who have the opportunity to become Professional Engineers through licensing, and noted that attaining a credential or title is a source of pride. One survey respondent also noted that certification might promote recruitment among underrepresented groups, although another person felt that it might have the opposite effect.

	Number of people we interacted with in this project[1]	Number of people we received quantifiable feedback from	pro	con
Interviews	87	87	29	4
RCOOS survey[2]	31	31	6	10
Industry survey	25	10	3	1
CPOP survey	202	202	72	34
Professional Society Council and ORRAP meetings	131			
D.C. meeting	18			
Ocean Sciences workshop	33			
Monterey workshop (who didn't fill out survey)	19			
Unsolicited response to website or Orion article, and not counted elsewhere	2			
SAMOS workshop	60			
UNOLS R/V tech workshop	13			
TOTAL[3]	**621**	**330**	**110**	**49**

Table 15. *Estimates of the total number of people with whom we interacted and the number expressing opinions for or against a CPOP.*

[1] *The list does not include people at other professional certification programs we communicated with since they were not considered the potential target audience for, nor beneficiaries of, a CPOP.*

[2] *As this was primarily an information gathering survey early in the CPOP project, we did not directly ask for the respondent's opinion, yea or nay on CPOP. Numbers pro and con are from the comments.*

[3] *Some of the numbers going into this total are estimates. Also note that some people may be counted more than once, if they participated in more than one of the activities listed. We have controlled for this where we had the necessary information, so the number of people participating in a given activity in this table may be less than is stated elsewhere in this report.*

Our investigation of existing professional certification programs was very enlightening. Given the number of occupational fields, some with strong similarities to oceanography, that have professional certification programs, it is almost surprising that there is not one for oceanography in the U.S. (We are not dismissing the UK-based IMarEST program, and will discuss it further in Section IV.F.) However, the number of certified individuals is in general fairly small, especially in relation to the amount of time and energy needed to set up and operate a certification program. But don't oceanographers want to be viewed with the same level of professional legitimacy as their peers in other environmental and earth sciences, as Michener et al. pointed out for ecologists (Michener et al., 2007)? Dr. Richard Spinrad, associate administrator of NOAA/OAR, wanted to raise visibility of the certification issue, and became a CMarSci to "put his money where his mouth is." He would like to see politicians and policy makers in Washington seeking advice from certified scientists (Spinrad, 2007). Indeed, IMarEST's experience is that shortly after the Chartered Marine Scientist designation became available, UK and EU government boards and councils began to appoint CMarSci holders. They are seen as a creditable source of advice.

Those involved with some of these other certification programs also point out that attaining a professional credential may lead to enhanced salaries relative to peers without a comparable credential. And as one certification program director put it: "People deserve to be recognized for their personal and professional achievement. They deserve to be set apart from those unwilling to work harder, contribute, reeducate, act ethically, etc."

Several participants in the interviews, surveys, and workshops cited the growth in ocean observing systems as an incentive for creating a CPOP. As one survey respondent said: "Our community is poised for growth in operational oceanography driven by societal needs. Society will need to have tangible reason to trust our operational results *a priori*, and certification in key areas can help engender that trust."

B. Arguments Against Certification

Twenty-eight percent of CPOP survey respondents felt that there is no way to define a certification program for a field as diverse as ocean science / technology, and that voluntary certification could lead to mandatory licensure in the future. No more than 28 percent felt that any of the statements listed as potential hindrances were reasons not to have a CPOP (Table 8), whereas at least

one third of the survey respondents agreed that each of the statements listed as potential benefits were reasons to have a CPOP (Table 7).

A number of other arguments against a CPOP were offered. Even given the relatively low fees for other professional certification programs, several people felt it would be a financial burden on individuals, especially students. Although certification programs do not in general turn a profit (Table 2), a few people saw them as "capitalistic driven programs that need to stay out of the sciences." It is clear that some individuals had strong feelings on the topic, contributing such comments as: "certification programs lend credibility to unethical consultants" and the "certification process demeans the scientist."

Perhaps we can learn a little from the American Scientific Glassblowers Society's (ASGS) experience. Professional scientific glassblowers either work in-house for academic or research organizations, as freelancers, or for one of the glass manufacturing companies that do custom work in addition to their production lines. There is great diversity in the skills and technology used in different applications, and the range of knowledge and experience needed varies among the different types of employment. According to Gary Coyne, secretary of the ASGS Southern California section and a scientific glassblower in the Department of Chemistry of California State University at Los Angeles, the ASGS went through a discussion about five years ago, similar to what oceanographers are going through now, and decided not to start a certification program. The issue that proved to be the major stumbling block was based on the egos involved. Professional scientific glassblowers did not trust others in the profession to judge them. They could not agree on who should make up and grade the examination, and there was no consensus on whether certification would be meaningful (Coyne, 2009a, 2009b).

Without a requirement, or at least strong incentive, there may not be enough impetus for people to apply for professional certification. We found, for instance, that very few of the engineers in the government agencies we interviewed held the Professional Engineers license, nor do young engineers want to pursue it since they do not need it for employment.[5] Since neither the states nor the federal government require hydrographer certification of their employees or contractors, the response to this program has been limited. This is especially striking given the fact that the Naval Oceanographic Office (NAVOCEANO) and NOAA each help sponsor International Hydrographic Organization (IHO)-accredited category A instruction programs, the former at USM and the latter at the University of New Hampshire, that can be used to satisfy much of the experience requirement for the certification (International Hydrographic Bureau, 2007).

The attitude towards professional certification in the United States appears to be different than in Europe, where chartered professionals are held in high regard and it is a desired credential. According to Bev MacKenzie, manager of technical affairs for IMarEST, parents in the UK want their children to become chartered professionals (MacKenzie, 2008). IMarEST does not have any hard evidence that people with the CMarSci credential are getting better jobs or are more successful than those without, but younger scientists definitely see being chartered as a selling point.

C. Target Audience for Certification

As noted in the November 2008 workshop breakout report, it is clear that a "one size fits all" certification program will not work for the wide array of oceanographic professionals. To stimulate discussion we drafted a multi-level, multi-track, multi-discipline/specialty certification framework (Appendix 1), incorporating elements from existing certification programs in similar fields. A majority of survey respondents (66 percent) felt that certification should be aimed at practitioners with a bachelor's as their highest degree, while 49 percent and 43 percent thought it should be geared towards those with a master's or associate's, respectively, as their terminal degree. Only a third thought certification should be aimed at individuals with a doctorate in the field (Table 11).

Over half the survey respondents identified operational oceanographer / forecaster (61 percent) and technician (57 percent) as occupational areas for which certification would be most useful (Table 12). These are the same areas which were named most frequently in the interviews (Table 4) and in written comments (Table 13).

D. Structure of a Certification Program

While our reviews of other professional certifications focused in large part on each of their main levels of certification, generally requiring a bachelor's degree and five years of experience (Appendix 4 and Table 2), many of the same sponsoring organizations also have a provisional or entry-level certification for people just finishing their formal education, and a more senior level for people with a graduate degree and many years of experience. Survey respondents favored that sort of multi-level approach to certification by a ratio of three to one.

The diversity in oceanographic expertise and experience can make it difficult to envision how a certification program could accommodate the broad array of specialties practiced by oceanographic professionals. Some certification programs have accomplished this by evaluating applicants' familiarity with a core body of knowledge, and

[5]Note that some of the interviews for this project were conducted before the economy was in its current dire straits. It is possible that attitudes are different now.

also their competence in one or more areas of specialization. By a ratio of 7:4, CPOP survey respondents favored requiring a basic level of knowledge across all aspects of ocean science and technology, as opposed to having expertise in just one aspect (Table 10). The survey also asked whether, in addition to demonstrating the broad basic level of knowledge, applicants needed to demonstrate a high level of competence in just one or both of a particular scientific sub-discipline of oceanography and a particular technology specialty. More people favored allowing demonstration of expertise in just one or the other (62 for just a scientific discipline; 40 for just a technology specialty), as opposed to requiring both (86). A few people objected to the idea of breaking things out this way.

E. Liability

The question of how certification might relate to liability and possible increases in litigation came up in a number of venues. Some people tied the issue of liability in certification to ocean observing systems and products. At the workshop, someone said that certified scuba instructors are required to have $1 million insurance and that perhaps something similar is needed for oceanographic professionals. It's hard to imagine that being a very popular idea. In part because we were looking at the possibility of a voluntary certification program, not a required licensure program, we did not as part of this project look into the liability issue, but it is clear that this topic warrants further investigation.

F. Possible Alternatives to a CPOP

IMarEST currently offers the charter credential, equivalent to certification, which is available to marine scientists and technologists from any country. The question arises as to why the United States would need another certification program. Two potential stumbling blocks to U.S. professionals attaining the CMarSci or CMarTech credential are a required interview (currently there are not enough chartered members in this country for the interview to take place here, although possibly this could be done via phone, video, or web conferencing), and the education requirement of a master's degree or the equivalent.[6] In addition, the processes to become chartered and to satisfy continuing professional development requirements are not as clearly laid out as one might wish for. Finally, it might also prove difficult for the IMarEST staff to evaluate the coursework for U.S. applicants coming from a large number of degree programs with no standardized curricula. That said, there is certainly something to gain from using a program that is already established and recognized.

Another alternative to a national certification program are certifications offered within an agency (e.g. NWS forecaster certification), a company, or an industry. For example, NAVOCEANO is exploring how to qualify its operational oceanography watch standers, and NDBC has an in-house certification process for its watch floor (known as the data assembly center) personnel. However, certification by an independent organization or professional society is more portable than one granted by an individual company or agency.

Another path—not exactly an alternative—is to concentrate on accrediting educational degree or certificate programs in the ocean science, technology, operations, and policy fields. Some of the new educational offerings in the ocean observing and operational oceanography arenas are described in Section III.G. We did not pursue this avenue as part of this project, but there was interest on the part of some of the interviewees, workshop participants and survey respondents in seeing more standardized curricula guidelines in the marine sciences. Should there be a CPOP, educational certificate programs might be tailored to help an individual successfully apply for professional certification. As an example, the ACSM-THSOA Hydrographer Certification accepts IHO-recognized programs of instruction as a substitute for some of their experience requirements.

G. Study Shortfalls

In a few areas, we came up short of our goals. We would have liked more input from users of ocean products and services who are not also providers. We tried but were unsuccessful in engaging policy makers in the discussion about certification. Also, we did not find any reports with quantitative information about the benefits of certification in a field similar to oceanography. While such studies may exist for education and health services occupations, we felt it was wandering too far afield to pursue such studies given the limited time and resources available for this project. Many of the certification program websites we reviewed offer testimonials from individuals and companies as to the value of certification, but as noted by David Walden, certification program manager at INCOSE, "providing quantifiable return on investment (individual and organizational) is one of the most challenging aspects." (Walden, 2009)

[6]IMarEST has recently introduced two new credentials, RMarSci and RMarTech, whose academic requirement is only a B.S. degree. Our extensive discussions with IMarEST took place before this development.

V. Conclusions/Recommendations

A number of professions similar to, and comparably diverse as, oceanography have one or more professional certification programs administered by professional societies or independent bodies. The number of certified individuals is small relative to the number of people in those professions, at least as judged from professional society membership. The time and effort, and to a lesser known extent, money, needed to start a new professional certification are substantial and the effort should not be undertaken lightly. Perhaps the most important things to consider before proceeding down that path are what difference the certification program will make and who cares.

We have only been able to partially answer those questions. There are undoubtedly some enthusiastic supporters of certification, but it is not clear that the broad support, or even a sufficiently large highly motivated group, has been identified to effectively carry out such an effort. Right now there is a high degree of ambivalence and misunderstanding within the oceanographic community as to what professional certification is. Roughly half of the approximately 330 people we received quantifiable input from could not be characterized as having an opinion for or against a CPOP. Among the remainder, opinions ran more than two to one in favor of a CPOP, and a higher percentage thought they would make use of a CPOP if it existed. We did not encounter widespread negative reaction to the idea.

As our following recommendations make clear, we do not think it would be productive to force a certification program from the top down, so to speak. We believe the effort expended to educate and engage all parties (potential applicants for certification, employers, users of ocean products and services, educators etc.) upfront, and throughout the process, would be worthwhile in the long run. Be prepared that creation of a new certification may be very contentious. Opinions pro and con may run quite strongly, and resistance will no doubt be encountered. Even making changes to an existing certification program, such as adding a continuing professional development requirement, is likely to raise ire (Marsh et al., 2004).

Our recommendations are:

1. **Follow a process similar to that used by IEEE to decide whether and how to proceed with a certification program.**

   Both industry and Navy representatives said that in order to get their support with proceeding to investigate certification, they would want a vote at the critical go / no-go decision points.

2. **Make sure there is a dedicated corps of people to set up and run a program before initiating it.**

   Certification programs depend heavily on volunteers to run them; including developing and grading exams, evaluating education and experience, interviewing candidates, etc. A large group of committed people is needed to do this.

3. **Ensure there is a market among employers.**

   This point was made repeatedly by the interviewees, workshop attendees, and survey respondents, as well as by the directors of other certification programs. While we have identified some employers who would welcome certification for oceanographic professionals, it is not clear that there is broad enthusiastic support at this point. For certain occupations, such as operational oceanographer / forecaster, there are a limited number of large employers in this country and we recommend further pursuing the issue with them.

4. **Identify and educate the target audience for certification, as well as users of oceanographic products and services.**

   By undertaking a considerable effort to educate the target audience for certification, as well as the users of oceanographic products and services, about certification, more support for the idea might be forthcoming.

5. **Focus on just a few occupations to begin.**

   Start with a carefully defined program for a subset of the ocean occupations. Operational oceanographers / forecasters and marine technicians are two areas that have been identified as perhaps being ripest for such an effort. The OSTO project recently conducted surveys and workshops to define the knowledge and skills for oceanographic instrumentation technicians and ocean forecasters. The output from these efforts could potentially be a starting point to define certification requirements for these occupations.

6. **Learn from existing programs.**

   Consult with others who have been through this process. INCOSE and AMS, for example, both offered their expertise.

7. **Consider partnering with other organizations already operating programs, such as IMarEST, ASPRS, AMS, etc.**

   For example, could TOS partner with ASPRS to offer certification in remote sensing of the ocean?

AMS already offers the CCM credential—could certification for consulting oceanographers be modeled after theirs and offered by another professional society in conjunction with them? Could MTS work with IMarEST to offer something similar to the CMarTech or RMarTech credentials but with lesser academic degree requirements?

8. **Consider a governance structure independent of professional societies.**

9. **Investigate liability issues.**

10. **Require an exam and continuing professional development as part of a CPOP.**

    Mike Renslow, past president of ASPRS, noted that "In the science field, all of the most respected certification programs require an application, a fee, references, and an exam. Within a specified period, individuals have to be recertified by an application (that documents their experience within a specified period), fee, and references." (Renslow, 2007) The hydrographer certification program, for instance, now uses a proctored exam as part of the certification process after having tried several other requirements.

11. **Seek national or even international accreditation.**

    Carefully study the requirements for accreditation of scientific / technical certification programs. Follow guidelines such as those laid out in ASTM International (1998) and adhered to by CESB and NCCA.

12. **Choose a name and logo, and start the trademark application process early.**

    If proceeding with a new professional certification program, investigate trademarking the name of the certification (e.g. Certified Oceanographic Professional) early in the process. More than one certification program officer offered this advice, as apparently it can take quite a long time to accomplish this step.

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List of Acronyms

AAEE - American Academy of Environmental Engineers
ABCEP - Academy of Board Certified Environmental Professionals
ACM - Association for Computing Machinery
ACSM - American Congress on Surveying and Mapping
AFS - American Fisheries Society
AGU - American Geophysical Union
AMS - American Meteorological Society
ANSI - American National Standards Institute
ASGS - American Scientific Glassblowers Society
ASLO - American Society of Limnology and Oceanography
ASPRS - American Society for Photogrammetry and Remote Sensing
AUV - autonomous underwater vehicle
CCM - Certified Consulting Meteorologist
CeNCOOS - Central and Northern California Ocean Observing System
CEng - Chartered Engineer
CEP - Certified Environmental Professional
CESB - Council of Engineering and Scientific Specialty Boards
CMarSci - Chartered Marine Scientist
CMarTech - Chartered Marine Technologist
CMOP - Center for Coastal Margin Observation and Prediction
CNMOC - Commander, Naval Meteorology and Oceanography Command
COMET - Cooperative Program for Operational Meteorology, Education and Training
CO-OPS - Center for Operational Oceanographic Products and Services
CPOP - certification program for oceanographic professionals
CSci - Chartered Scientist
CSEP - Certified Systems Engineering Professional
DOL - Department of Labor
ESA - Ecological Society of America
ETA - DOL Employment and Training Administration
GIS - geographic information systems
GISCI - Geographic Information Systems Certification Institute
GISP - Geographic Information Systems Professional
ICAB - International Certification Accreditation Board
ICE - Institute for Credentialing Excellence
IEC - International Electrotechnical Commission
IHO - International Hydrographic Organization
IEEE/OES - IEEE Oceanic Engineering Society
IMarEST - Institute of Marine Engineering, Science and Technology
INCOSE - International Council on Systems Engineering
IPEP - Institute of Professional Environmental Practice
ISO - International Organization for Standardization
MATE Center- Marine Advanced Technology Education Center
MMS - Minerals Management Service
MOA - memorandum of agreement
MTS - Marine Technology Society
NAVOCEANO or NAVO - Naval Oceanographic Office
NDBC - National Data Buoy Center
NCCA - National Commission for Certifying Agencies
NGO - non-governmental organization
NOCA - National Organization of Competency Assurance
NOAA - National Oceanic and Atmospheric Administration
NOS - National Ocean Service
NWS - National Weather Service
OAR - Office of Oceanic and Atmospheric Research
OMM - Offshore Minerals Management (now known as Offshore Energy and Minerals Management)
OPM - Office of Personnel Management
OOS - ocean observing systems
ORION - Ocean Research Interactive Observatory Network
ORRAP - Ocean Research and Resources Advisory Panel
OST - ocean sciences and technology
OSTO - ocean sciences, technology, and operations
OSU - Oregon State University
PE - Professional Engineer
QA/QC - quality assurance / quality control
QEP - Qualified Environmental Professional
RCOOS - Regional Coastal Ocean Observing Systems
RFP - request for proposals
ROV - remotely-operated vehicle
RMarSci - Registered Marine Scientist
RMarTech - Registered Marine Technologist
SAMOS - Shipboard Automated Meteorological and Oceanographic Systems
SOC - Standard Occupational Classification
STARS - Spatial Technology and Remote Sensing
TAMU - Texas A&M University
TAMOOS - Texas A&M Ocean Observing Systems Certificate
THSOA - The Hydrographic Society of America
TOS - The Oceanography Society
UH - University of Hawaii
UNOLS - University-National Oceanographic Laboratory System
USM - University of Southern Mississippi
WCET - Wireless Communication Engineering Technologies

Appendix 1

MATE
MARINE ADVANCED TECHNOLOGY EDUCATION CENTER

This project is funded by NOAA's National Ocean Service and Office of Oceanic and Atmospheric Research.

Additional information about this project can be found at:
www.marinetech.org/CPOP

Does the U.S. need a Certification Program for Oceanographic Professionals?

The Marine Advanced Technology Education Center is funded by NOAA to conduct a study to assess whether there is a need in the U.S. for a voluntary certification program for professionals working in the fields of oceanography or marine science and technology. We are soliciting your opinion on this topic. We anticipate that it will take no more than 30 minutes to read the background material provided, and fill out the short survey. We will send you a stylish laser pointer pen as a thank you for your time.

Professional certification has been defined as "the voluntary mechanism for validating professional knowledge and expertise in a specialty" (Harris, The Guide to National Professional Certification Programs, 3rd ed., HRD Press, Amherst, MA., 2001). Professional certifications are generally offered by a non-governmental agency, such as a professional society, or an independent organization formed for that purpose. It should not be confused with an educational certificate, which is a document granted by an academic institution attesting to completion of a course of study not leading to a degree.

Through the evaluation of education, experience, references, and in some cases, exams and/or interviews, professional certification programs seek to identify those individuals who have successfully put their education into practice. Many professional certification programs have a continuing professional development requirement to encourage career-long learning. Many professions have found certification to be beneficial to employers (e.g., enhanced confidence in the knowledge, skills and accomplishments of employees and perspective employees), customers (e.g., increased confidence in products and services, and ease in finding qualified professionals), and the individuals who become certified (e.g., may lead to performance awards and promotions, and increase marketability and career opportunities).

The increase in operational oceanography activities and growth in ocean observing systems, along with increased public attention to ocean issues, have caused some ocean professionals to ask whether the time is right to initiate a certification program for oceanographic professionals in this country. There is presently no professional certification available for the broad array of ocean science, management, and technology practitioners, though certifications and licenses do exist for some ocean related occupations (e.g., commercial divers, ship's personnel). There are a number of U.S.-based certifications for environmental professionals, and there are U.K.-based professional certification programs for marine scientists and technologists. (Tables 1 and 2).

We appreciate your help and look forward to receiving your completed survey within 30 days. To answer some of the survey questions, you will need to refer to the following sample framework for a certification program for oceanographic professionals.
Please fill out this survey at:
http://www.surveymonkey.com/s.aspx?sm=QdvaoDcytvwxYyDUuI_2bIeA_3d_3d

Thank you,

Deidre Sullivan, Tom Murphree, and Leslie Rosenfeld (*Principal Investigators)*
Marine Advanced Technology Education Center
Monterey Peninsula College
Monterey, CA

For further information, please e-mail cpop@marinetech.org.

Table 1. Examples of existing professional certification programs related to the environmental sciences.

Certification	Certifying organization	Web Site
Certified Ecologist	Ecological Society of America	www.esa.org/careers_certification/
Board Certified Environmental Engineer	American Academy of Environmental Engineers	www.aaee.net/Website/WhyCertified.htm
Certified Environmental Professional	Academy of Board Certified Environmental Professionals	www.abcep.org
Qualified Environmental Professional	Institute of Professional Environmental Practice	www.ipep.org
Registered Environmental Manager	National Registry of Environmental Professionals	www.nrep.org
Fisheries Professional	American Fisheries Society	www.fisheries.org/afs/education.html
GIS Professional	GIS Certification Institute	www.gisci.org
ACSM-THSOA Certified Hydrographer	National Society of Professional Surveyors	www.nspsmo.org
Certified Lake Manager	North American Lake Management Society	www.nalms.org/CLMProgram
Chartered Marine Scientist	Institute of Marine Engineering, Science and Technology (U.K.)	www.imarest.org/membership/registration
Chartered Meteorologist	Royal Meteorological Society (U.K.)	www.rmets.org/activities/cmet
Certified Consulting Meteorologist	American Meteorological Society	www.ametsoc.org/amscert
Certified Photogrammetrist, Certified Mapping Scientist – Remote Sensing	American Society for Photogrammetry & Remote Sensing	www.asprs.org/membership/certification
Professional Wetland Scientist	Society of Wetland Scientists	www.wetlandcert.org

Table 2. Summary of some pertinent information about programs listed in Table 1.
For some questions, the number of programs to which a given answer applies is shown in parentheses. For other questions, a range is given that encompasses all the answers obtained for that question. Lists without numbers are an amalgamation of the answers given by all the programs. Note that we were unable to obtain answers to every question for every program.

Question	Answer
Who administers the certification program?	Government-sanctioned professional society (2); professional society (8); independent agency or organization (4)
In what year was the program initiated?	1957-2004
What organizations accredit the program?	International Certification Accreditation Board, Council of Engineering and Scientific Specialty Boards
What organizations recognize the certification?	Air Force, Army Corps of Engineers, Dept. of Energy, EPA, National Park Service, NOAA, U.S. Forest Service, USGS, U.S. Postal Service, state and local governments, National Association of Counties, port authorities, courts, University Consortium for GIS, National State Geographic Information Council, some companies
How many people have this certification?	51 - 1664
How many applicants fail to get certified?	< 2% or “very small” (4), 5% (1), 15% (2), 36% (1)
What are the fees?	1st time: $50 - $600; renewal: $35 - $275
What are the education requirements?	None (3); bachelor’s degree (10, including some that require certain courses or that the degree is in engineering or science); master’s degree (1)
How many years of experience are needed?	2 – 16 yrs; 5 yrs is most common. For some, M.S. may be used to substitute for 1-2 yrs; Ph.D. for 2-3 yrs. For one, B.S., M.S. or Ph.D. each count for 0.5 yrs of experience.
What kinds of tests must applicants take?	None (7); written (4); written or oral (1); written and oral (2). In two programs, the written exam may be waived if applicant has 15-16 yrs experience.
What are other application requirements?	References; signed code of ethics; technical report; essay; oral presentation and/or interview; membership in a professional society; professional engagement in the field
What kind of continuing requirements are there?	Point system for professional development activities (9); none (3); submission of continuing professional development log (2)
What is the recertification interval?	5 yrs (8; some also have an annual fee); 3 yrs (1); 1 yr (4), none (1)

Sample Framework for a Certification Program for Oceanographic Professionals

We describe in this section a sample framework for a program that would include certification for oceanographic professionals at different levels in their careers, on different career tracks, in different disciplines, and with different technical specialties. This multi-level, multi-track, multi-disciplinary, and multi-specialty framework would allow for a phased implementation of the program. For instance, it could be initiated with just one level and one track and just a few disciplines and specialties, and be expanded upon later. This is just one example of how a certification program for oceanographic professionals might be structured. The main point of this example is to promote discussion of the concept of certification for oceanographic professionals, and to provide a common basis for that discussion.

LEVELS

- **Entry, associate, or intern**
  Certification at this level would be based on education, and possibly some experience and/or an exam. Would require an Associate or higher degree with appropriate courses. Examples: The Institute of Professional Environmental Practice (IPEP) has an Environmental Professional Intern credential for people studying for, or with, a B.S. or M.S. and less than five years experience. The Ecological Society of America (ESA) offers an Associate Ecologist credential, which requires a bachelors or higher degree plus one year work experience.

- **Professional**
  Certification at this level would be based on education, experience, an exam, and references. Would require a B.S., M.S., or Ph.D. plus a certain number of years of experience based on highest degree. Exam would cover basic knowledge across breadth of marine science and technology, plus detailed knowledge in one or more oceanographic disciplines, and one or more technical specialties. The type of education and experience required, as well as the exam, would be different for the different tracks. Example: the test for Qualified Environmental Professional, administered by IPEP, consists of a general environmental science part, plus a choice of one of four specialty parts. All of the certification programs we reviewed (Tables 1 and 2) have something equivalent to this level.

- **Master, Senior, or Fellow**
  Certification at this level would be based on experience at high levels in the profession. Would require M.S. or Ph.D. plus certain number of years and types of experience, and might require prior certification at the professional level. Example: ESA has a Senior Ecologist credential, in addition to Associate Ecologist and Ecologist. Their senior level requires a Ph.D. and five years experience, or a M.S. and 10 years experience.

TRACKS (or career paths)

- **Scientist** • **Resource Manager** • **Technician** • **K-14 Educator**

These are just examples. There could be more, fewer, or other tracks. Applicants would choose at least one track. Example: The Institute for Marine Engineering, Science, and Technology (Tables 1 and 2) offers Chartered Marine Scientist and Chartered Marine Technologist credentials.

OCEANOGRAPHIC DISCIPLINES

- **Acoustics**
- **Biology**
- **Chemistry**
- **Engineering**
- **Geology**
- **Geophysics**
- **Microbiology**
- **Physics**
- **Policy**

OCEAN TECHNOLOGY SPECIALTIES

- **Laboratory analyses**
- **Electronics**
- **GIS**
- **Information technology**
- **Data collection, quality-control, and/or visualization**
- **Numerical modeling and/or high performance computing**
- **Remote sensing**

Again, these are just examples; there could be more, fewer, or other disciplines and specialties. Applicants for certification would choose at least one discipline and one specialty.

Appendix 2

Oceanographic Professional Certification Survey

A document providing background information needed to complete this survey can be downloaded from \www.marinetech.org/cpop/survey

1. How would you describe your current connection to the marine field?

- ☐ Undergraduate student in ocean science or technology
- ☐ Graduate student in ocean science or technology
- ☐ Alumnus of an ocean science or technology program not currently employed in a marine-related job
- ☐ Ocean science or technology educator
- ☐ Non-supervisory employee in a ocean-related job (other than education)
- ☐ Supervisor in a marine-related job (other than education)
- ☐ User of ocean data or information who is not directly employed in the marine field, and is neither a student in, nor an alumnus of, an ocean science or technology program.

2. How old are you?

3. What is your highest degree in an oceanography-related field?

- ◯ Associate
- ◯ Bachelor
- ◯ Master
- ◯ Doctorate

4. What aspect of the oceanographic professions most closely matches your job experience or interests?

- ☐ Biology
- ☐ Chemistry
- ☐ Environmental management
- ☐ Fisheries
- ☐ Geology
- ☐ Hardware Technology (equipment, instrumentation, platforms etc.)
- ☐ Information Technology
- ☐ Physics
- ☐ Policy
- ☐ Other (please specify)

5. With what type of organization is your present primary affiliation?

- [ ] Business/industry
- [ ] Educational institution
- [ ] Civilian government agency (local, state, or federal)
- [ ] Military
- [ ] Nongovernmental organization (NGO, community or activist-based organization)
- [ ] Public utility
- [ ] Research institution
- [ ] Other (please specify)

6. Do you envision applying for a new job in the marine field in the foreseeable future?

- ◯ Yes
- ◯ No
- ◯ Not sure

7. Do you currently possess, or have you investigated pursuing, any professional certification?

- ◯ No, I don't possess, nor have I investigated pursuing, any professional certification.
- ◯ I do not possess any professional certification, but I have investigated pursuing professional certification.
- ◯ Yes, I hold the following professional certification(s):

8. If you are in a supervisory or management position, do you consider professional certifications in your hiring, promoting, or contracting decisions?

- ◯ Yes
- ◯ No
- ◯ Not a supervisor or manager

9. For which of the following reasons do you think there should be a certification program for oceanographic professionals? Check all that apply. A certification program would:

- [ ] Help to identify qualified individuals by documenting an individual's experience and proficiency in a way that other measures do not
- [ ] Increase confidence in oceanographic products and services
- [ ] Promote career-long learning through continuing professional development requirements
- [ ] Increase marketability and career opportunities
- [ ] Provide a personal sense of achievement for those individuals that attain the credential
- [ ] Increase the visibility of marine-related professions
- [ ] Help to define a common body of knowledge in the field
- [ ] Improve ocean-related education and aid in development of the ocean-related workforce
- [ ] I do not think there should be a certification program for oceanographic professionals.
- [ ] Other (please specify)

10. For which of the following reasons do you think there should not be a certification program for oceanographic professionals? Check all that apply.

- [ ] Voluntary certification could lead to mandatory licensure in the future.
- [ ] Certification would add an unnecessary hurdle to an individual's career path.
- [ ] Even with a framework such as laid out in the background document (linked at the top of this survey), there is no way to define a certification program for a field as diverse as ocean science / technology.
- [ ] There is no acceptable way to objectively assess an individual's qualifications.
- [ ] There is no identified problem which a certification program would fix.
- [ ] It would be time-consuming and expensive to set up and run a certification program for oceanographic professionals.
- [ ] I think there should be a certification program for oceanographic professionals.
- [ ] There are already professional certification programs in existence which meet this need; such as:

11. Please list below any other reasons why you think there should not be a certification program for oceanographic professionals.

12. How would you use certification? Would you (check all that apply):

- [ ] Consider applying for certification yourself
- [ ] Consider certification in making hiring and/or promotion decisions
- [ ] Use evidence of certification to promote your services or products
- [ ] Look for certified individuals when seeking advice on oceanographic matters
- [ ] Give more weight to oceanographic information supplied by certified individuals
- [ ] Consider making changes to courses or curricula to help your students attain certification
- [ ] I don't think I would make use of a certification program for oceanographic professionals.
- [ ] Other (please specify)

13. Do you favor a multi-level approach for a certification program, such as outlined in the sample framework in the background document linked at the top of this survey?

- ◯ Yes
- ◯ No

14. Do you think certification should be aimed at individuals who hold the following as their highest degree in the marine field? You may check more than one.

- [ ] Associate
- [ ] Bachelor
- [ ] Master
- [ ] Doctorate

15. For which tracks (such as suggested in the sample framework) do you think certification would be useful? These are not necessarily exclusive; check all that apply.

- [ ] Computer Scientist
- [ ] Consultant
- [ ] Educator
- [ ] Environmental/Resource Manager
- [ ] Operational Oceanographer / Forecaster
- [ ] Research Scientist
- [ ] Technician
- [ ] None
- [ ] Other (please specify)

16. Do you agree that successful applicants for certification should possess a certain basic level of knowledge across all aspects of ocean science and technology?

- ◯ Yes, I think applicants should have broad knowledge across the field of oceanography.
- ◯ No, I think expertise in one discipline or specialty is adequate.

17. Do you agree that certified oceanographic professionals should demonstrate a high level of competency in at least one oceanographic discipline AND one ocean technology specialty?

- ◯ Yes
- ◯ No, I think competency in just a discipline is adequate for at least some tracks.
- ◯ No, I think competency in just a specialty is adequate for at least some tracks.

18. Please list specific oceanographic disciplines or technology specialties, or combinations thereof (e.g., physical oceanography and numerical modeling) for which you think certification is especially needed?

19. Other comments?

20. Would you like to receive a free laser pointer pen as a thank you gift? If yes, enter your name and address here:

Appendix 3

OCEAN SCIENCE, TECHNOLOGY AND OPERATIONS (OSTO)
WORKFORCE WORKSHOP
NOVEMBER 10-12, 2008
MONTEREY, CA

PARTICIPANT LIST

NAME	ORGANIZATION	STATE
Brian Bingham	Olin College	Massachusetts
Jerry Boatman	Planning Systems Inc. & Marine Technology Society	Mississippi
Mel Briscoe	The Oceanography Society	Washington D.C.
Caroline Brown	MATE Center	North Carolina
Lisa Campbell	Texas A&M University	Texas
Marie Colton	NOAA / National Ocean Service	Washington D.C.
Greg Crawford	Humboldt State University	California
Sharon Franks	Scripps Institution of Oceanography	California
Scott Fraser	Long Beach Community College	California
Daniel Goroff	Alfred P. Sloan Foundation	New York
Melvin Greer	Lockheed Martin	Virginia
Norman Guinasso	Texas A&M University	Texas
Rich Jeffries	Naval Meteorology and Oceanography Command	Mississippi
Jim Kendall	Minerals Management Service	Maryland
Judy Kildow	Monterey Bay Aquarium Research Institute	California
Frank Klein	Oceaneering International	Louisiana
Donna Kocak	Harris Corporation	Florida
Justin Manley	Battelle	Massachusetts
Maggie Merrill	Marine & Oceanographic Technology Network	Massachusetts
Drew Michel	ROV Technologies & Marine Technology Society	Texas
Jerry Mills	NOAA / National Ocean Service	Washington D.C.
Erica Moulton	MATE Center	Florida
Tom Murphree	Naval Postgraduate School	California
Maria Osiadacz	MATE Center	California
Katie Rathmell	Center for Coastal Margin Observation and Prediction	Oregon
Wayne Reed	Oceaneering International	Louisiana
Bob Ridky	US Geological Survey	Washington D.C.
James Rigney	Naval Oceanographic Office	Mississippi
Herb Ripley	Hyperspectral Imaging Limited	Canada
Leslie Rosenfeld	Naval Postgraduate School	California
Jacqueline Rousseau	NOAA / Educational Partnership and Student Scholarship Programs	Washington D.C.
Michael Ryan	Naval Meteorology and Oceanography Professional Development Center	Mississippi
Marcos Sastre-Cordova	Raytheon Integrated Defense Systems	Rhode Island
Sandy Shor	University of Hawaii	Hawaii
Pete Simpson	Cape Fear Community College	North Carolina
Paul Siri	Ocean Science Applications	California
Shawn Smith	Florida State University	Florida
Peter Stone	NOAA / National Ocean Service	Washington D.C.
Arliss Sturgulewski	Alaska Sea Grant Advisory Panel	Alaska
Deidre Sullivan	MATE Center	California
Harold Syms	Minerals Management Service	Maryland
Ray Toll	SAIC	Virginia
Jan van Smirren	Fugro GEOS	Texas
Tom Wiener	IEEE Oceanic Engineering Society	Virginia
Jill Zande	MATE Center	California

Appendix 4

Summary Of Information About Some Existing Professional Certification Programs

Certified Ecologist (information verified by ESA Executive Director)

Website	http://www.esa.org/careers_certification/
Info as of	20 August 2007
Sponsor	Ecological Society of America
Start year	1981
Recognizing organizations	Some state agencies require this certification for employees and consultants
# people certified	420
% applicants who fail	Less than 1 %
# members in sponsor org.	Over 10,000
Fees	Associate Ecologist: $75/$150; Ecologist: $125/$250; Senior Ecologist: $125/$250 (member / non-member)
Administration	ESA elected Board of Professional Certification
Education requirements	**Associate Ecologist:** Bachelor's or higher degree in ecology or a related science from an accredited college or university **Ecologist:** Master's or higher degree in ecology or a related science **Senior Ecologist:** Doctoral degree in ecology or a related science
Experience requirements	**Associate Ecologist:** at least 1 yr of post-graduate professional experience. **Ecologist:** at least 2 yrs of full-time equivalent professional experience OR at least 5 yrs of professional experience in addition to the education requirement for Associate Ecologist. **Senior Ecologist:** at least 5 yrs of professional experience OR at least 10 yrs professional experience in addition to the education requirement for Ecologist. Additional experience necessary to qualify at this level includes: a) demonstration, in work output, of thorough knowledge of the literature, scientific principles and theories of ecology, b) written original contributions or original interpretation of ecological information, and c) supervision of projects. Experience must follow completion of the degree level used to qualify for Ecologist.
Test requirements	None listed
Other requirements	Two letters of recommendation (one from an ESA member); read and subscribe to the ESA Code of Ethics; include a cover letter indicating the reasons you are seeking certification as an Ecologist and why you believe it should be granted; provide a list of publications and/or reports.
Continuing requirements	None listed
Renewal interval	Recertification every 5 years

Board Certified Environmental Engineer (BCEE);
Board Certified Environmental Engineering Member (BCEEM)

Website	http://www.aaee.net/Website/WhyCertified.htm http://www.aaee.net/Website/Membership.htm
Info as of	29 November 2006
Sponsor	American Academy of Environmental Engineers
Start year	1955 (under a different name)
Recognizing organizations	Accredited by CESB
# people certified	Not available
% applicants who fail	Not available
# members in sponsor org.	Not available
Fees	Application processing: $75; Examination fee: $150; Renewal fee: $160
Administration	AAEE Admissions Committee and Board of Trustees
Education requirements	Bachelor's degree in engineering or related field. Valid license or certificate of registration to practice professional engineering (P.E. license not required for BCEEM).
Experience requirements	16 yrs of experience to certify without qualifying examinations. 8 yrs of experience to apply for certification by written and oral examinations.
Test requirements	Specialty-specific written and oral examinations if 16-yr experience level not met. Specialties are: • AP (Air Pollution Control) • GE (General Environmental Engineering) • HW (Hazardous Waste Management) • IH (Industrial Hygiene) • RP (Radiation Protection) • SE (Sanitary Engineering) • SW (Solid Waste Management) • WW (Water Supply and Wastewater)
Other requirements	Be professionally engaged in environmental engineering activities on a fulltime basis.
Continuing requirements	40 Professional Development Hours (PDH) in previous 2 yrs to remain active. (Report not required for renewal, however 2% of members are audited each year.) Inactive status (renewal fee still required) is available for those who don't want to complete PDH. No challenges, suspension or revocation of P.E. license.
Renewal interval	Specialty certification renewal required annually. After 20 yrs of continuous certification, LIFE status may be earned (no renewal fee required).

Certified Environmental Professional (CEP)

Website	http://www.abcep.org/
Info as of	7 November 2007 (except as noted below)
Sponsor	Academy of Board Certified Environmental Professionals (ABCEP)
Start year	1979
Recognizing organizations	Accredited by CESB. CEP logo trademarked by US Patent & Trademark office. CEP credential recognized by courts around the country as a valid credential for senior professionals in the environmental field. CEP certification exceeds requirements of the U.S. EPA's definition of Environmental Professional and conforms to ASTM's requirements for conducting Phase I Environmental Site Evaluations. Firms such as Enviro-Sciences, HDR and HNTB recognize the value of the CEP, and have awarded bonuses or salary increases of $1,000 or more to staff who earn the CEP designation. Website has a long list of companies that will pay the annual certification fee for their employees. CEP program is endorsed by the National Association of Environmental Professionals (NAEP).
# people certified	69 listed on website (as of 4 March 2009)
% applicants who fail	15% (some reasons are listed on web site).
# members in sponsor org.	Not applicable
Fees	$125 application fee; $125 final certification fee; $100 yearly fee.
Administration	ABCEP is a non-profit organization, independent of NAEP, which administered the CEP prior to 1999.
Education requirements	Bachelor's degree and ≥ 9 yrs professional experience, or Master's degree and ≥ 8 yrs experience, or Doctorate and ≥ 7 yrs experience.
Experience requirements	Minimum of 9 yrs of applicable professional environmental experience (may be reduced by 1-2 yrs as noted above), 5 yrs of which must be in a position of responsible charge and/or responsible supervision. Certification offered in 5 functional areas: environmental assessment, documentation, operations, planning, and research & education.
Test requirements	Exam, a series of essay questions, is self-proctored, open-book, take-home. There is great flexibility in selecting which of the questions to answer. The exam seeks to demonstrate that the applicant has the knowledge, skills and abilities of a senior environmental professional.
Other requirements	8 reference letters; transcripts; phone interview. Must subscribe to ABCEP Code of Ethics and Standards of Practice for Environmental Professionals, established by NAEP and adopted by ABCEP.
Continuing requirements	40 hrs of continuing professional development credit each year to maintain certification. For most professionals, 20 hrs are earned for full-time employment. Remaining 20 hrs may be earned for activities such as: continuing education activities, participation in or attendance at industry conferences, service on environmentally-related boards and committees, publishing papers in peer-reviewed journals.
Renewal interval	Annually

Qualified Environmental Professional (QEP)
(information verified by IPEP Executive Director)

Website	http://www.ipep.org
Info as of	15 November 2006
Sponsor	Institute of Professional Environmental Practice (IPEP)
Start year	1993
Recognizing organizations	Accredited by CESB. QEP is 1 of 5 environmental credentials that meets ASTM standards. EPA and Air Force recognize QEP certification.
# people certified	As of 18 Feb. 2008: 894 QEPs (792 are in U.S.); 78 Environmental Professional Interns (40 in U.S.)
% applicants who fail	
# members in sponsor org.	Not applicable
Fees	Oral exam route: $100 application fee; $200 exam fee if accepted to the exam. Written exam route: $75 application fee; $150 exam fee if accepted to the exam. $150 annual renewal fee.
Administration	PEP is governed by a Board of Trustees, including representatives of the participating organizations, as well as at-large members.
Education requirements	To qualify with oral exam: baccalaureate degree To qualify with written exam: baccalaureate degree in physical, earth or natural sciences, engineering, or mathematics
Experience requirements	To qualify with oral exam: 15 yrs of professional environmental work experience acceptable to IPEP, subsequent to bachelors degree. At least 10 qualifying yrs of work experience must be in a position of responsible charge. To qualify with written exam: 5 yrs of professional environmental work experience acceptable to IPEP, subsequent to bachelors degree; or a baccalaureate or equivalent degree in another discipline and 8 subsequent yrs of qualifying work experience.
Test requirements	Test consists of a general environmental science part, and a choice of 1 of 4 specialty parts. There is a certification and examination guide for the written test. For oral exam, applicant submits an abstract with the application and if accepted to the exam, gives an oral presentation on an environmental program or project representative of the applicant's work.
Other requirements	References from 3 environmental professionals, including at least one from a QEP (for the oral exam route). Application includes a release of liability and an ethics pledge.
Continuing requirements	Recertification required every 5 yrs. 50 credits of professional development are required over the 5 yrs. There is a list of how many credits are awarded for different activities.
Renewal interval	Annually

Registered Environmental Manager (REM)*

Website	http://www.nrep.org
Info as of	28 April 2008
Sponsor	National Registry of Environmental Professionals (NREP)
Start year	1988
Recognizing organizations	Accredited by International Certification Accreditation Board. Recognized by: U.S. Postal Service, National Park Service, U.S. Forest Service; Resolution Trust Corporation, U.S. Air Force, U.S. Dept. of Energy, Amtrak, State of Alabama and other state agencies, as well as many local governments
# people certified	Not available
% applicants who fail	Not available
# members in sponsor org.	Not applicable
Fees	Application/exam fee: $250; Annual renewal fee: $90
Administration	NREP is incorporated and legally recognized as a not-for-profit, non-member accrediting and certification organization providing professional credentials worldwide in the form of certifications and registration to qualified individuals. NREP is comprised of a Board of Directors, Board of Operating Governors, Professional Practice and Ethics Committee, Exam Committee, Government Liaison Committee, Industrial Liaison Committee and advisory boards of environmental educators, governmental officials and industrial managers. Individuals who become professionally credentialed by NREP may participate on its boards and committees.
Education requirements	Bachelor's degree in an environmentally-related discipline. Recognized majors include physical, biological and health sciences; engineering and environmental majors. 3 yrs of acceptable work experience may be substituted for each year of an academic degree program.
Experience requirements	5 yrs work directly related to environmental engineering, health, science or management
Test requirements	2 ¾ hr timed, 150 multiple-choice questions, closed-book exam. Candidates must pass with a scaled score of 700 or better.
Other requirements	Ethics certification and attestation; endorsement of a NREP credential-holder
Continuing requirements	To maintain status as a REM in good standing, REMs must: abide by the NREP Code of Ethics; submit the REM Annual Maintenance Fee; and obtain and submit Continuing Professional Education credits. 15 approved contact hrs of continuing education or environmental service are required during each recertification cycle in order to maintain certified status.
Renewal interval	Annually

*NREP offers several other certifications including Associate Environmental Professional (entry level) and Certified Environmental Scientist.

Certified Fisheries Professional (CFP)

Website	http://www.fisheries.org/afs/certification.html
Info as of	02 December 2006
Sponsor	American Fisheries Society (AFS)
Start year	1963, with "significant" changes in 1997
Recognizing organizations	AFS plus "a few states" and "some employers."
# people certified	About 1,600, or 20%, of AFS members have some form of AFS certification.
% applicants who fail	Not available
# members in sponsor org.	Total membership: "over 8,000."
Fees	$100 for AFS members; $200 for non-members of AFS.
Administration	The Board of Professional Certification is composed of 15 Certified Fishery Professionals who represent all the Divisions and volunteer their time to review applications. The Board is composed of 3 subcommittees: Experience, Education and Professional Experience.
Education requirements	Must have a bachelor's, master's, or doctoral degree with sufficient course work in following subjects: fisheries and aquatic sciences; other biological sciences; physical sciences; math and statistics; communications; and human dimensions.
Experience requirements	Required post-degree, professional-level (not technician or student level) work experience: 5 yrs after bachelor's; 4 yrs after master's; 2 yrs after doctoral.
Test requirements	None
Other requirements	Sign code of ethics; qualifying, experience related professional communications
Continuing requirements	Professional development quality points required. May be obtained by a combination of: formal additional education in fisheries and non-fisheries subjects; short courses; participation in professional conferences and workshops; oral and written communications; and service.
Renewal interval	5 yrs. Renewal based on continued work experience, plus continuing education and/or professional development.

Certified Lake Manager (CLM) and Certified Lake Professional (CLP)
(information verified by NALMS President)

Website	http://www.nalms.org/nalmsnew/Scientist.aspx?id=27&Mid=1
Info as of	21 September 2007
Sponsor	North American Lake Management Society (NALMS)
Start year	1990
Recognizing organizations	EPA, many towns that use lake manager services
# people certified	< 100
% applicants who fail	5%
# members in sponsor org.	1,500
Fees	$250 plus NALMS membership ($30-100 depending on category) Recertification fee is $75
Administration	NALMS Certification Board
Education requirements	4-yr undergraduate degree. Acquisition of at least 6 credits in each of 5 categories and 14 additional credits in one of these categories (the CLM/CLP's "major").
Experience requirements	A minimum of 2 yrs of employment in a position that meets the description of a lake manager or lake professional. Qualifying lake manager experience should include involvement in nearly all phases of a project, although prospective CLMs do not necessarily have to be in charge of any phase. Qualifying lake professional experience should include involvement in the appropriate technical phases of a project pertinent to his/her specific expertise, although prospective CLPs do not necessarily have to be in charge of any phase.
Test requirements	None
Other requirements	None
Continuing requirements	5 continuing education units, as approved by the NALMS Certification Board, over a 3 yr period
Renewal interval	3 years

Chartered Meteorologist (CMet)

Website	http://www.rmets.org/activities/cmet/index.php
Info as of	4 January 2007
Sponsor	Royal Meteorological Society (U.K.)
Start year	1993
Recognizing organizations	Courts and boards of enquiry have sought evidence of CMet accreditation in the past
# people certified	51
% applicants who fail	Not available
# members in sponsor org.	Not available
Fees	Application fee: £133; Renewal fee: £32 (for 2005)
Administration	"Council oversees the accreditation scheme and has appointed an Accreditation Board to manage it." There are 8 members of the Board. The Chairman is a member of Council with Officer status. Not more than 4 members of the Board are employed by any one employing organisation. Board appointments aim to provide a balance of specialisms which will enable Panels to be selected to best advantage. There is also a Course Evaluation Panel with at least 4 members, to evaluate the education requirements portion of the application.
Education requirements	"The normal requirement is a UK or other EU degree in any science, engineering or computational subject or a non-EU equivalent. An alternative qualification may be accepted in the case of someone with considerable relevant practical experience." "A minimum level of knowledge of meteorology is required."
Experience requirements	"A minimum of 5 yrs recent work at an appropriate professional level is required. Successful completion of a master's degree course in a relevant specialisation may count as 1 yr of work; completion of a PhD in meteorology may count as 2 yrs. Referees will also be asked to comment on a candidate's ability to analyse material logically and to comment on the candidate's experience and judgement."
Test requirements	None
Other requirements	Application form and references. Ability to communicate in English. Interview with panel of experts assigned by the Board.
Continuing requirements	"Requests for renewal must be accompanied by a statement from the individual certifying continued professional activity. At 5-yearly intervals from the date of original accreditation fresh evidence will be sought to confirm that the individual continues to merit accreditation."
Renewal interval	Annually

Note that in the U.K., "chartered professionals" are like "certified professionals" in the U.S., and the Royal Meteorological Society uses "accreditation" to mean what in the U.S. is called "certification."

Certified Consulting Meteorologist (CCM)
(information verified by AMS Special Programs Manager)

Website	http://www.ametsoc.org/
Info as of	30 July 2007
Sponsor	American Meteorological Society (AMS)
Start year	1957
Recognizing organizations	
# people certified	364 active
% applicants who fail	Very low failure rate. ~0-2% fail per year.
# members in sponsor org.	11,000 AMS Members
Fees	$300 AMS members, $600 non-members; $40 renewal for members, $120 for non-members
Administration	AMS Board of CCMs within Commission on Professional Affairs
Education requirements	Same criteria as for AMS membership. B.S or higher degree in atmospheric or related science; or B.S. or higher degree in another science, but be working in atmospheric or related science; or 20 semester hrs of credit in the atmospheric or related oceanic or hydrologic sciences at an accredited institution of higher learning with 3 yrs of professional experience in the last 5 yrs.
Experience requirements	5 yrs. M.S. can substitute for 1 yr; Ph.D. can substitute for 2 yrs.
Test requirements	Written and oral exams
Other requirements	Technical report, transcripts, references
Continuing requirements	Accumulate 28 Professional Development score points every 5 years. This requirement is being phased in over 2004-2009
Renewal interval	Yearly

Certified Photogrammetrist; Certified Mapping Scientist, Remote Sensing; Certified Mapping Scientist, GIS/Land Information Science; Certified Photogrammetric Technologist; Certified Remote Sensing Technologist; Certified GIS/LIS Technologist

(information verified by Chair of the ASPRS Evaluation for Certification Committee and the ASPRS Licensure Examination Committee)

Website	http://www.asprs.org/membership/certification/certification_guidelines.html#GENERAL_INFORMATION
Info as of	6 June 2007
Sponsor	American Society for Photogrammetry & Remote Sensing (ASPRS)
Start year	1975 for Photogrammetrist; 1991 for Mapping Scientist (Remote Sensing and GIS/LIS)
Recognizing organizations	ASPRS Certified Professionals are specified as a requirement for contract services by the U.S. Army Corps of Engineers, the U.S. Geological Survey, state and local government agencies when procuring services. ASPRS Certification is recognized by employers seeking to fill positions. ASPRS Certified Professionals work closely with the National Council for Examination of Engineers and Surveyors on the development and maintenance of a national photogrammetry exam to support implementation of the Model Law by individual states.
# people certified	Total number of active certified: 860 (Membership in ASPRS not required; ~ 60 are outside of the U.S.)
% applicants who fail	In 2006: 14% failed to be certified or failed to be recertified.
# members in sponsor org.	6,150
Fees	Initial certification: $275 (ASPRS members); $400 (non-members) Recertification: $150 (members); $275(non-members) Fees for Technologist Certifications are less
Administration	ASPRS Board of Directors, Evaluation for Certification Committee, Professional Conduct Committee, Professional Practices Division
Experience requirements	*Certified Photogrammetrist*: 6 yrs experience in photogrammetry, 3 yrs of which were in a position of professional responsibility demonstrating professional knowledge and competence *Certified Mapping Scientist,* Remote Sensing: 3 yrs of experience in photogrammetric and/or cartographic applications, all of which have been in a position of responsibility that demonstrated knowledge and competence in planning and application; 3 yrs of specialized experience at a professional level in remote sensing and interpretation of data from various imaging systems and/or design of remote sensing systems *Certified Mapping Scientist, GIS/LIS:* 3 yrs experience in mapping sciences or photogrammetry in a position of responsibility demonstrating professional knowledge of and competence in mapping science and mapping procedures; 3 yrs of professional experience in the Geographic or Land Information Systems, during which professional knowledge and competence in those systems were demonstrated *All Technologist categories:* A total of three years experience, of which two are in the specialty category. Bachelor's, master's, or doctoral degree in engineering, or the natural or physical sciences, counts as ½ yr experience. For technologists only, an associate's degree also counts as ½ yr experience.
Test requirements	Successful completion of written exam
Other requirements	Declaration of compliance with the Code of Ethics of the ASPRS; references from four persons who are holding, or who have held, responsible positions in the appropriate field and have first-hand knowledge of the applicant's professional and personal qualifications.
Continuing requirements	Four references who have knowledge of the applicant's professional and personal involvement in the last 5 yrs. Each applicant must earn 25 points based on criteria that will be reviewed by the evaluation for Certification Committee
Renewal interval	Recertification every 5 yrs.

Professional Wetland Scientist (PWS)

Website	http://www.wetlandcert.org
Info as of	13 November 2006
Sponsor	Society of Wetland Scientists (SWS)
Start year	Not available
Recognizing organizations	Not available
# people certified	Not available
% applicants who fail	Not available
# members in sponsor org.	Not available
Fees	Professional Wetland Scientist: $200 member/$300 nonmember Wetland Professional in Training: $100 member/$200 nonmember $35 annual fee to maintain registration
Administration	SWS Certification Committees
Education requirements	BS, BA or equivalent or higher degree with coursework including Biological Sciences (15 semester hrs), Physical Sciences (15 hrs), Quantitative Sciences (6 hrs) and wetland-related (15 hrs – may be short courses or continuing education courses).
Experience requirements	5 yrs full-time professional experience, gained with 10 yrs prior to certification application. Up to 2 yrs of credit will be allotted for a master's degree, up to 3 yrs for a Ph.D., and up to 4 yrs for a master's and a Ph.D.
Test requirements	None listed
Other requirements	Five references (three must be SWS members, two must be PWS); acceptance of SWSPCP Code of Ethics.
Continuing requirements	None listed
Renewal interval	Renew certification at 5 yr intervals

Geographic Information Systems Professional (GISP)
(information verified by GISCI Executive Director)

Website	http://www.gisci.org
Info as of	15 August 2007 (except as noted below)
Sponsor	GIS Certification Institute, a non-profit organization established just for GIS certification 501 (c)(6).
Start year	2004
Recognizing organizations	Member organizations: Association of American Geographers (AAG), National State Geographic Information Council (NSGIC), University Consortium for Geographic Information Science (UCGIS), Urban and Regional Information Systems Association (URISA). North Carolina, Oregon, and the National Association of Counties have endorsed the program. A number of small groups and chapters have shown informal and formal support for the program.
# people certified	3,231 Certified GIS Professionals (GISPs) as of 28 December 2008
% applicants who fail	Each month a handful of applications that fail. However, the GISCI application process is different from most certification programs. Applicants have a strong idea on whether or not they will pass when the application is submitted. We do have applications that fail due to miscalculations, misrepresentations, and documentation errors.
# members in sponsor org.	Not applicable
Fees	$250, recertification is $115.
Administration	The four member organizations appoint representatives to the Board of Directors. GISCI has a staff of 3 (Executive Director, Certification Coordinator, Accountant).
Requirements	GISCI uses a point-based system for certification. Achievement (points) must fall into three categories. Minimum points = 150. Educational Achievement: Bachelor's degree with some GIS courses (or equivalent) (30 points) Professional Experience: 4 yrs in GIS application or data development (or equivalent) (60 points) Contributions to the Profession: Annual membership and modest participant in a GIS professional association (or equivalent) (8 points) Plus an additional 52 flex points in any of the three categories.
Test requirements	None
Continuing requirements	Every 5 yrs the applicant must earn 75 points Educational Achievement: 3 pts Professional Experience: 37 points Contributions to the Profession 7 points Additional "Flex" Points: 28 pts
Renewal interval	Every 5 yrs an applicant must submit a recertification application.

ACSM-THSOA Hydrographer Certification

(information verified by Vice-Chairman of certification board)

Website	http://www.nspsmo.org/index.cfm?fuseaction=Page.viewPage&pageId=515
Info as of	8 August 2007
Sponsor	National Society of Professional Surveyors (NSPS), member organization of American Congress on Surveying and Mapping (ACSM).
Start year	1981 (combined separate inshore and offshore certifications in 1997); first certifications in 1984
Recognizing organizations	Considered by many federal, state and local agencies as well as private firms, seeking subcontractors when evaluating technical proposals for marine engineering, surveying, and construction. These include port authorities, NOAA and the Corps of Engineers. The certification program is also endorsed by The Hydrographic Society of America which provides financial support through annual contributions.
# people certified	Approximately 200
% applicants who fail	36% of examinees have failed since the inception of new exam in 2001
# members in sponsor org.	Not available
Fees	$50 application fee; $150 exam fee
Administration	ACSM Hydrographer Certification Board
Education requirements	None listed. Certification suggested for surveyors, engineering technicians, dredge operators, geo-physical exploration surveyors/geologist, hydrographers, principles in architecture-engineer firms
Experience requirements	To qualify to take the exam, applicant must have 5 yrs experience in hydrographic surveying (2 yrs if applicant has completed IHO-recognized category A program of instruction, 3 yrs if category B course has been completed) of which 2 are in responsible technical charge of surveys and 2 have been in the field. The 2 yrs in technical charge and the 2 in the field may be counted for the same time period if appropriate.
Test requirements	Must pass exam with an aggregate score of 70%
Other requirements	Four references. Note, the certification is not a substitute for registration which most states require.
Continuing requirements	This is being considered but none at present.
Renewal interval	Under consideration (in fall 2008, a self recertification program was approved. Fee will be $30 for 3 yrs)

Chartered Marine Scientist (CMarSci) (information verified by IMarEST officials)

Website	http://www.imarest.org/Membership/GradesofMembership.aspx
Info as of	23 July - 27 September 2007
Sponsor	Institute of Marine Engineering, Science and Technology (IMarEST)
Start year	2002
Recognizing organizations	Privy Council. Shell and BP in U.K. require CMarSci credential.
# people certified	81, about ¼ of those are outside the U.K., only two in the U.S.
% applicants who fail	Most who fail the first time reapply and pass. Very rare for someone to not eventually get accepted. The whole process can take years.
# members in sponsor org.	15,000 in > 100 countries; 800 marine science members
Fees	£25.00
Administration	"IMarEST, by virtue of its Royal Charter and By-Laws may award the titles ….Chartered Marine Scientist and Chartered Marine Technologist to its members who are appropriately qualified." "As a Licensed Body of the Science Council the Institute is empowered to register its Chartered Marine Scientists, who are appropriately qualified, as Chartered Scientists (CSci). The Science Council is an independent body uniting the key Professional Institutions and Learned Societies across science in the UK."
Education requirements	Master's degree or equivalent
Experience requirements	> 4 yrs post-graduate experience plus proven demonstration of achievement in 5 areas referred to as the A to E competencies: **A** Technical/scientific knowledge and understanding **B** Application of knowledge and understanding in practice **C** Leadership, management and supervisory skills **D** Interpersonal skills **E** Professional conduct
Test requirements	None
Other requirements	None
Continuing requirements	IMarEST encourages continuing professional development (CPD) but has no specific requirement. CPD is part of the code of professional conduct that a person signs to become chartered. They only look at a person's CPD record if there's a complaint against them, which rarely happens. The Science Council requires a CPD record to be submitted every 5 yrs. There's a continuing professional development guide.
Renewal interval	5 yrs Note that in the U.K., "chartered professionals" are like "certified professionals" in the U.S.

National Weather Service (NWS) Forecaster Development Process

Based on NWS web sites and talks by Tom Murphree with NWS forecasters, in particular,
Warren Blier, science and operations officer / senior forecaster at NWS office in Monterey, CA

1. Overview

To be hired as an entry level forecaster at NWS, an applicant must have completed specific college courses, and an undergraduate degree in meteorology, atmospheric sciences, or hydrology. Colleges offering meteorology programs are generally aware of, and offer, these required courses. Many of these college programs receive a form of accreditation by applying for and meeting the requirements for membership in the University Corporation for Atmospheric Research (UCAR). NWS is not directly involved in this accreditation. Currently, it seems that the supply of potential forecasters greatly exceeds the demand at NWS. One consequence of this, apparently, is that successful applicants for NWS forecaster positions generally have a bachelor's or master's degree, and/or significant prior work experience (e.g., experience as a weather forecaster for the military).

The NWS forecaster certification process is a formal, in-house process that takes about three years to complete and is required in some form for all meteorological (met) interns. There is also a NWS Doppler radar certification process that is a formal, in-house process that takes about 100 hours to complete and is required of all forecasters. Additional professional development is required of forecasters, but the specific amounts and types of professional development (PD) vary with the individual.

The NWS processes for determining the qualifications of applicants and employees are important within NWS, and perhaps within NOAA as a whole. However, it is unclear to what extent they are recognized by other employers, or otherwise apply to employment outside NOAA/NWS.

2. NWS Forecaster Certification

NWS has a formal process for forecaster certification, called the Forecaster Development Program (FDP). This process applies mainly to preparing met interns (the term for entry level forecasters) or other qualified NWS employees to become general forecasters (the NWS term for journeyman forecasters). There is apparently no formal process for advancement from general forecaster to senior forecaster (the third and highest level of forecaster). The term met intern may be a little misleading. Met interns are regular GS government employees and have generally started their jobs with a bachelor's or master's degree in meteorology (all new applicants must have at least an undergraduate degree in meteorology, atmospheric sciences, or hydrology).

The FDP education and training is based on materials from the NWS Professional Development Series (PDS). These materials describe and help prepare met interns to acquire the knowledge and skills needed to become general forecasters. Details on FDP subjects and materials are available at the NWS training Center site (see FDP site below). The FDP is completed over a course of at least 2 years, and generally three years. The FDP process includes the use of online materials, simulations, and on-the-job training.

The process is overseen by the employee's supervisor who may approve deviations from the standard process.

The employee's progress through the FDP is monitored and logged via the NOAA/NWS e-Learning System. However, no formal certificate is issued. In practice, completion of the FDP is not an absolute requirement for advancement to a general forecaster position. Due to a limited supply of met interns to fill the available general forecaster positions, met interns are sometimes promoted to general forecasters without having first completed the FDP. There does not appear to be a formal recognition by organizations outside NOAA of the FDP process as a certifying process. Blier suggested that other branches of NOAA besides NWS may have similar employee development programs.

All forecasters are required to complete Doppler radar training. This is apparently an across-the-board and absolute requirement for all forecasters at all levels. The training involves about 100 hours of education and training, including a lot of hands-on work, and an exam.

3. Other NWS Certification and Professional Development Efforts

There is also a fairly extensive NWS professional development process (see PDS web site below). There does not appear to be a formal and standardized set of PD requirements for forecasters. However, some amount of PD seems to be generally expected. The extent of that PD seems to vary with the individual employee, supervisor, and NWS office.

In addition to the FDP for forecasters, there is a formal NWS process for qualifying weather observers (the people who collect weather observations, for example, at airports).

Most, and perhaps all, of the NWS formal education, training, and professional development requirements and optional opportunities seem are accessed and managed via the NOAA/NWS e-Learning System.

4. Web Sites

Forecaster Development Program (FDP)
http://www.weather.gov/directives/020/pd02001003a.pdf
http://www.nwstc.noaa.gov/nwstrn/d.ntp/pds.html#fdp

NWS Professional Development Series (PDS)
http://www.nwstc.noaa.gov/nwstrn/d.ntp/pds.html

Doppler Radar Training: Distance Learning Operations Course
http://www.wdtb.noaa.gov/courses/dloc/index.html

National Weather Service Training Center
http://www.nwstc.noaa.gov/

Professional Geologist (this is a license, not a certification)

Web sites	http://www.geology.ca.gov/ (CBGG). http://www.asbog.org/ (ASBOG).
Info as of	02 December 2006
Sponsor	California Board for Geologists and Geophysicists (CBGG)
Start year	1968
Recognizing organizations	CA government plus cooperating states. CA recognizes professional experience from, and National Association of State Boards of Geology (ASBOG) exam completion by, out-of-state applicants.
# people certified	Professional Geologists: 4,939 Specialties: Professional Geophysicists: 226 Certified Engineering Geologists: 1,601 Certified Hydrogeologists: 845
# members in sponsor org.	Not applicable
Fees	Application fee: $250; exam fee: $300.
Administration	CBGG is composed of eight members: two geologists, one geophysicist, and five members from the public.
Education requirements	Must have a bachelor's, master's, or doctoral degree in geological sciences.
Experience requirements	Minimum of 5 yrs of professionally responsible geological work experience (not technician level work experience). Education and upper division or graduate teaching may substitute for work experience; e.g. a bachelor's degree counts for 2 yrs work experience; a master's degree counts for 3 yrs experience.
Test requirements	Must pass ASBOG exam on academic and practical aspects of geology, plus a CA-specific exam. Both exams are administered by CBGG.
Other requirements	References from work supervisors. Specialty certifications are available only to Professional Geologists who meet additional work experience requirements.
Continuing requirements	None
Renewal interval	None

Certified Systems Engineering Professional (CSEP)

Web sites	http://www.incose.org/educationcareers/certification/
Info as of	4 February 2009
Sponsor	International Council on Systems Engineering (INCOSE)
Start year	Foundation level since 2004; added entry level (Assoc. SEP) and DoD Acquisition Specialist in 2008; expert (ESEP) level being added in 2009
Recognizing organizations	Federal Highway Administration, CA Dept of Transportation, DoD, Booz Allen Hamilton, General Motors, Lockheed Martin, Northrop Grumman, SAIC, Scientia Global
# people certified	324 CSEPs; 10 ASEPs
#applicants who fail	
# members in sponsor org.	6,720
Fees	For CSEP: Application fee: $400 ($300 for members); Examination fee: $80; Renewal fee: $150 ($100 for members)
Administration	INCOSE Certification Advisory Group, consisting of 9 CSEPS, is responsible for procedures and tests
Education requirements	Technical bachelor's Degree for CSEP or ASEP; can substitute 5 extra yrs experience for non-technical bachelor's, or 10 extra yrs for no bachelor's
Experience requirements	5 yrs for CSEP (see Systems Engineering competency list on website for explanation of depth and breadth of experience required); none for ASEP
Test requirements	2-hr 120-question exam based on INCOSE SE Handbook v3.1 for CSEP or ASEP
Other requirements	3 references for CSEP
Continuing requirements	Minimum of 120 Professional Development Units per renewal interval
Renewal interval	3 yrs for CSEP; 5 yrs for ASEP

Appendix 5

Interview Comments

Comments from individual interviewees are bulleted, with explanatory terms added in brackets as necessary. Specific areas of expertise mentioned for possible certification are highlighted in bold.

Comments regarding certification made during the Navy interviews:

- Industry certifications helpful in IT.
- NAVO [Naval Oceanographic Office] has internal certification process for senior NAVO rep on survey ships.
- It's a problem that there are no real agreed-upon bachelor's degree requirements for oceanography, might be interested in certification for that reason.
- OPM [U.S. Office of Personnel Management] doesn't accept professional certifications, would be great if it did.
- **Visualization**, **data management**, and **science applications** are areas where certification might be helpful.
- No NAVO employees have gotten the field part of the **hydrographic certification**; would like to see NAVO personnel get the cat A certification, and see the Navy follow international standards.
- There should be certified **oceanographers** and **geophysicists**.
- Might be useful to have certification to know when to promote.
- N6 [The Navy IT division] requires a variety of DoD [Department of Defense] certifications: acquisition certification, chief information officer. Hires contractors with industry certification, but doesn't look for industry certification for GS [general schedule or civil service] employees because then he just loses them to industry, doesn't think there needs to be separate IT certification in oceanography.
- There is mandatory certification in IT, budget, and administration, but not on science and technical side. They envision having **ocean ops floor** certification.
- Working on certifications: which occupations, what methods, defining skill sets, they are planning a Surveyor Qualification Program. Draft job qualifications requirements for oceanographers and acousticians are being developed on the military side.

Comments regarding certification made during the MMS interviews:

- Engineers, even supervisors, are not required to be licensed, just need a bachelor's degree, no in-house certification of any kind.
- They do look for IT certifications in various areas: computer security etc.
- Neither MMS nor industry requires Professional Engineers license, so few people get it.
- Don't look at any kind of certifications, would be against certification if it limited applicant pool, wouldn't want to require certification.
- Doesn't pay attention to PE or certifications.
- Thinks requiring certification would limit pool of applicants, Army Corps has project management certification.

- A good professional certification program might address some issues if a position required it.

Comments regarding certification made during the NOS interviews:

- NOAA's role in hydrographic surveying should be to certify **surveyors** who then work for surveying contractors; contractors want to be able to say that they have certified workers but don't want to have to certify them themselves. It is helpful to NOAA to know that its contractors are certified.
- She could imagine that NOAA require that people contracted for science support be certified, but it is unclear what the relationship could be between certification and civil service requirements.
- Agree certification would be good for employees' professional development.
- Like idea of multi-level certification.
- Has American Fisheries Society (AFS) certification. Louisiana requires AFS certification for working in fisheries. Would like to see a certification in **integrative science policy**. Strongly supports **oceanography** certification.
- There's an internal certification program for scientific support coordinators. They do not look for environmental certification.
- Office of Coast Survey has no requirement for hydrographic certification, even for survey leaders. Recognize they have to move toward more formal certification. They encourage but don't require contractors to have **hydrographic certification**.
- Certification of **people who produce real-time products** might make sense if it was part of overall certification of the product generation process (e.g., certification of equipment, procedures, data, people, etc.). Had not thought about certification for CO-OPS [Center for Operational Oceanographic Products and Services] folks, but thought it might be helpful for outside people. Agrees that ocean products that affect lives and property are potential candidates for certification; he is very interested in certification.
- Some of her employees may have some sort of planning certificate, but certification isn't an issue for them.

Comments regarding certification made during the NDBC interviews:

- It will be hard to define certifications for the OSTO professions, and these definitions shouldn't be static. A title or credential is something to be proud of, like being a Professional Engineer.
- Any certification needs to be credible and well-regulated.
- Would like to see certification for **technicians**.
- Certification requirements for non-IT members of the ocean workforce should include, at a minimum, successful completion of introductory information technology or software engineering training; this would facilitate communication of ocean project requirements between different workforce members and IT support staff.
- Certification will fill need for a way to judge whether people can do a particular job, especially needed for **data analysts** and **technicians**.

Comments regarding certification made during the interviews with academicians and researchers:

- There's a need to know who knows what they're doing.
- There may be a need for bachelor's and master's level people to get certified for **marine monitoring and management** as they use more and more sophisticated equipment, such as *in situ* sensors and autonomous systems. They will need to understand how to do calibrations and validations because regulatory decisions may have significant economic and environmental consequences. Professional societies could set up standards for this. Definitely saw TOS as a better fit than AGU for doing professional certification.

- There is no single education program that provides both environmental science and technical skills, might help to have a certification for **marine technicians**.
- Thought certification in the areas of **high performance computing** or **data visualization** might be useful.
- Concerned that certification would increase bureaucracy and paperwork. Sees department hires as more education-driven, doesn't see much role for certification, although she's not ruling out consideration of certification in the future. Agrees that a continuing professional development requirement could be good.
- Think about whether completion of an academic certificate program could substitute for some years of experience in a national oceanography certification program; also think about national guidelines for operational oceanography or ocean observing curricula.

Comments regarding certification made during the interviews with supervisors at oceanography-related companies:

- Professional certification benefits both the company by providing a means to demonstrate the competence of the staff when responding to RFPs, and the individual employee by providing a professional accreditation outside of traditional engineering.
- Loves the idea of certification, definitely looks at certification in hiring.
- Certification is needed for **operational oceanographers**.

Appendix 6

Final: 15 Dec 2008

MEMORANDUM OF AGREEMENT
establishing a joint project on
PROFESSIONAL CERTIFICATION OF OCEANOGRAPHERS
among the
American Meteorological Society
Marine Technology Society
The Oceanography Society

I. PARTIES

This document constitutes an agreement among the American Meteorological Society (AMS), the Marine Technology Society (MTS), and The Oceanography Society (TOS). Hereinafter, the three Societies will be referred to individually as AMS, MTS, or TOS, or together as the Societies.

II. AUTHORITIES

As scientific and professional societies, this agreement is restricted to collaboration within the constitution, by-laws, articles of incorporation, and/or any other constraints applicable to each of the Societies. The agreement is among the Executive Directors of each of the Societies, and does not carry the weight of the entire society unless specifically endorsed by each society council or equivalent, under the rules of that society.

III. PURPOSE

Pursuant to this agreement, the Societies will collaborate on a joint project on Professional Certification for Oceanographers, to include the following topics:

1. definition of need, including potential market, benefits, and issues of concern;
2. development of a pilot program to test and refine the concepts and methods;
3. implementation plan, including organizational roles, roll-out schedule and costing;
4. evaluation program and metrics, to ensure quality and relevance; and
5. other topics as mutually decided.

It is particularly noted that this agreement does not commit any of the Societies to a professional certification program, or to endorsing or participating in one. The agreement is to work together to construct a possible program, and to make the decisions mutually as to whether to proceed or stop.

Deliverables and schedule, to be adjusted as needed, are:

1. item (1) above, by 15 Dec 2008
2. item (2) above, ready for external review, by 15 Apr 2009
3. item (3) above, ready for external review, by 15 Jul 2009
4. item (4) above, ready for external review, by 15 Sep 2009
5. possible program roll-out (TBD) at MTS/IEEE Oceans '09, Biloxi, 26-29 Oct 2009
6. possible program roll-out (TBD) at AMS Annual Meeting, Jan 2010
7. possible program roll-out (TBD) at TOS Biennial Meeting, Portland OR, 22–26 Feb 2010

The roll-out dates in deliverables 5, 6, 7 are the earliest possible dates; delays and new dates will be decided as part of this agreement.

IV. MUTUAL INTEREST OF THE PARTIES

This joint project is of mutual interest to the Societies because each of them is concerned in its own sphere about workforce development, career opportunities, continued professional development, and operational capacity building within the ocean science and technology community, especially with the potential for large, operational observing and forecasting systems under the aegis of the Integrated Ocean Observing System (IOOS). These concerns include university training, internships, liability issues, and public awareness and confidence.

V. RESPONSIBILITIES OF THE PARTIES

(a) The AMS agrees to perform the following activities and provide the following resources in support of the joint project on Professional Certification for Oceanographers:

1. AMS will provide senior professional time for discussions and activities relevant to this project at a level not to exceed four working days per month, on average.
2. If a certification program is established, AMS will promote the program to its members in a variety of ways, including no fewer than two full-page ads per year in the Bulletin of the AMS.
3. AMS will work with the other parties to this agreement and with its membership to develop the programs, review certification materials as they are developed and to monitor and measure program performance.
4. AMS will contribute to serving as the certifying body; specifics and level of contribution TBD.
5. AMS will cover the costs associated with these contributions.

(b) The MTS agrees to perform the following activities and provide the following resources in support of the joint project on Professional Certification for Oceanographers:

1. MTS will provide senior professional time for discussions and activities relevant to this project at a level not to exceed four working days per month, on average.
2. MTS will contribute to developing a guide to the ocean science body of knowledge.
3. MTS will work with the other parties to this agreement and with its membership to develop the programs, review certification materials as they are developed and to monitor and measure program performance.
4. MTS will contribute to serving as the certifying body; specifics and level of contribution TBD.
5. MTS will cover the costs associated with these contributions.

(c) TOS agrees to perform the following activities and provide the following resources in support of the joint project on Professional Certification for Oceanographers:

1. TOS will provide senior professional time for discussions and activities relevant to this project at a level not to exceed four working days per month, on average.
2. TOS will provide liaison to the NOAA-funded study activities on Certification and on Workforce Needs at the MATE Center, Monterey Peninsula College.
3. TOS will provide liaison to the university graduate education programs in the ocean sciences, to the Ocean Studies Board, to the Consortium on Ocean Leadership, and to the Ocean Research and Resources Advisory Panel.
4. TOS will work with the other parties to this agreement, with its membership, and with the bodies in paragraphs 2 and 3 above, to develop the programs, to review certification materials as they are developed and to monitor and measure program performance.
5. TOS will contribute to serving as the certifying body; specifics and level of contribution TBD.
6. TOS will cover the costs associated with these contributions.

VI. EQUITABLE APPORTIONMENT OF COSTS

This current agreement does not cover possible future activities beyond those already mentioned, hence the costs of any activities beyond those specifically mentioned in section V will be apportioned as they are developed and determined.

VII. WORKING GROUP

The signatories to this Agreement will designate a Professional Certification for Oceanographers Working Group to carry

out the tasks of the joint effort, and to make reports and recommendations to the signatories for consideration by the Societies. The initial members are:
Marie Colton, AMS; Jerry Boatman, MTS; and Melbourne Briscoce, TOS.

VIII. CONTACTS

The contacts of each party to this agreement are:

American Meteorological Society
Keith L. Seitter; telephone: 617-227-2426, ext. 220; e-mail: kseitter@ametsoc.org

Marine Technology Society
Richard Lawson; telephone: 410-884-5330; e-mail: rich.lawson@mtsociety.org

The Oceanography Society
Jennifer Ramarui; telephone: 301-251-7708; e-mail: info@tos.org

The Societies agree that if there is a change regarding the information in this section, the society making the change will notify the other societies in writing of such change.

VIII. PERIOD OF AGREEMENT AND MODIFICATION/TERMINATION

This agreement will become effective when signed by all parties. The agreement will terminate on 1 July 2011, but may be revised or renewed at any time by mutual consent of the parties.

Any party may terminate this agreement by providing 60 days written notice to the other parties. In the event this agreement is terminated, each party shall be solely responsible for the payment of any expenses it has incurred. This agreement is subject to the availability of funds.

IX. OTHER PROVISIONS

Should disagreement arise on the interpretation of the provisions of this agreement, or amendments and/or revisions thereto, that cannot be resolved at the operating level, the area(s) of disagreement shall be stated in writing by each party and presented to the other parties for consideration. If agreement on interpretation is not reached within thirty days, the parties shall terminate or modify the agreement to resolve the conflict.

SIGNATURES

Keith L. Seitter, AMS **Date**

Richard Lawson, MTS **Date**

Jennifer Ramarui, TOS **Date**

The opinions expressed in this report are those of the authors and not neccessarily those the National Oceanic and Atmospheric Administration (NOAA).
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