

# Alliance for Coastal Technologies

PROGRAM EVALUATION FINAL REPORT

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## EXECUTIVE SUMMARY

The Alliance for Coastal Technology (ACT) was initiated by the NOAA Coastal Services Center (CSC) in 2001. ACT is designed to facilitate the creation and application of knowledge of current and emerging ocean-observing technologies to improve the capabilities of existing observations and deliver new technological solutions to address specific global environmental issues and operational ocean observing challenges. It achieves its objectives through specific technology transfer efforts involving both emerging and commercial-ready technologies and the explicit involvement of coastal resource managers, small and medium-sized firms, and world-class marine science institutions. The desired results are new knowledge, new skills, new technologies, and new economic opportunities.

An evaluation was conducted to provide information about how well ACT is working to achieve its outcomes and to support strategic decisions on ACT's future directions, such as what products should be continued to be offered, what new products should be introduced, and what features should be included in continuing or new products. The evaluation also included an examination of two other technology evaluation programs, the U.S. EPA's Environmental Technology Verification (ETV) Program and the NOAA NOS CO-OPS Ocean Systems Test and Evaluation Program (OSTEP) to understand their structure and processes in relationship to ACT.

The following questions formed the structure of the evaluation:

- Are ACT Products Relevant?
- Are ACT Products Credible?
- Does ACT's Product Delivery System Promote Effective Stakeholders' Learning and Skills?
- Are ACT's Products Being Used?

The primary tool to answer these overarching questions was semi-structured interviews with ACT stakeholders, including ACT staff, representatives of ocean instrument companies and a range of ocean industries, state coastal managers, ocean researchers, IOOS Regional Association Directors, NOAA program office staff, and staff of other Federal agency regional offices and laboratories. Secondary data for the evaluation was collected from a number of different sources, including official ACT, NOAA, and ETV program archival documents (e.g., proposals, proposal reviews), publications, and reports.

Some of the core findings of the evaluation include:

- **Coastal managers and ocean industries regard ACT's unbiased information on technology performance as an important factor in selecting new technologies.** Coastal managers are risk adverse and tend to use technologies that have been time-tested and proved to be reliable. Vendor-generated data on technology performance is viewed with skepticism. Reports from well-established research centers such as the ACT Partner institutions, instills some confidence in the information.
- **Ocean technology companies agree that ACT evaluations contribute to improvements in their technologies and improve acceptance in the market.** Small and medium enterprises had no means for third-party evaluation of their technologies prior to ACT. Most testing has been done in-house, and on some occasions, field testing was done in collaboration with a research customer. Technology providers also believed that buyers will tend to be more confident in an instrument if they see it is backed by a public body.
- **The utility of ACT technology evaluations could be enhanced with additional, follow-on services.** Despite the positive contribution of the technology evaluation reports, coastal managers still felt a need for additional information on technology use before committing to adopting an

innovation. Managers indicated they needed “how-to” knowledge, and especially how best to apply the technology to perform some task, in addition to descriptive knowledge.

- **Academic ocean researchers are less likely to utilize ACT evaluations for technology decisions.** Researchers tend to believe that peer reviewed laboratory and field experiments by individual scientists is the preferred way to “promote innovation while shielding the operating system from unproven or immature ideas.”
- **ACT stakeholders agree that ACT workshops create an excellent foundation for establishing “roadmaps” for transition and adoption of new technologies.** ACT workshops provide unique opportunities for peer-to-peer, cross-sector, and multi-disciplinary networking; and contribute to knowledge synthesis on existing capabilities and consensus-building on next steps to move technologies forward.
- **Federal agencies have a key role in evaluating the readiness of emerging environmental monitoring technologies for mission operations.** NOAA assisted in the creation and continued implementation of ACT and OSTEP. Similarly, ETV was created and has been sustained for over two decades by EPA. ACT and ETV are viable due to the large contribution made by NOAA and EPA, respectively. The total costs of evaluations are too high to be supported by vendor contributions, alone, especially small and medium-sized businesses.
- **ACT, OSTEP, and ETV are complementary and have been successful in meeting intended objectives.** Each program has similar missions share a number of features at the organizational-level of design and implementation. However, each occupies a different position in the research to operations continuum. A comparison of the costs of individual verification is difficult, since they are strongly technology and program specific.

Stakeholders offered a number of recommendations consistent with the evaluation findings:

- **Expand outreach and communications.** Emphasis should be placed on mechanisms to achieve a wider and more effective dissemination of knowledge about ACT and its products to national and international stakeholders.
- **Expand the use of multi-stakeholder interactions as a tool to follow-up ACT technology workshops and verifications.** Priority should be given to develop activities to disseminate procedural knowledge.
- **Ensure that the selection of technology workshops and evaluations is clearly and consistently tied to NOAA IOOS Program priorities and reflect regional needs, in coordination with the IOOS Regional Associations.**
- **Explore opportunities to forge stronger links with other NOAA program offices and other agencies to encourage cross-partnerships for technological advancement of ocean observing and monitoring.** These programs include NOAA/NOS OSTEP, NOAA laboratories, the National Science Foundation Ocean Observing Initiative, and the US Coast Guard.
- **Enhance credibility of ACT products.** Achieve buy-in of the leading experts in relevant fields by engaging them early and often in developing and reviewing ACT projects, in particular the technology evaluations. Improve awareness of ACT’s quality systems, including external peer review.

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## **INTRODUCTION**

Two keys to successful technology adoption are choice and certainty. Several requirements must be met to ensure technology users are able to make informed choices to adopt the most appropriate technology for a given application in a given locale:

- needs well defined, documented and understood;
- several technology alternatives, all of which are well and reliably characterized in terms of environmental and economic performance;
- capability to make the chosen technology fully operational; and
- methods that facilitate choice of an optimal technology.

A lack of certainty of technical viability, and the consequential high levels of risk are major impediments to the adoption of new technologies. Coastal managers are risk-adverse; they cannot afford technology failures. Removing barriers to technology adoption often translates into increased certainty, and decreased risks, for technology users. One example is ensuring access to sufficient, verified information on technology performance.

The concept and practice of verification of environmental technologies are a recent development. Generally speaking, verification can be defined as the mechanism or process for establishing or confirming the performance of a technology, product or process under specific, predetermined criteria or protocols and adequate data quality assurance procedures. The pioneer program is the U.S. Environmental Protection Agency's Environmental Technology Verification Program (ETV) begun in 1995. ETV was designed as a means to accelerate market acceptance of innovative environmental technologies. Verification also is considered an important step in the transition of new technologies into operational systems, preceding certification of operational readiness.

### **ACT Program Description**

#### ACT Development and Structure

The genesis for the Alliance for Coastal Technologies began with studies commissioned by the NOAA Coastal Services Center (CSC) in 1998-1999 to assess the usefulness of a technology verification system for coastal managers and ocean technology companies (Table 1). These studies 1) confirmed that coastal managers had an important need for objective information on the performance on in situ sensors and systems for monitoring coastal waters and 2) proposed a networked "co-laboratory" organizational structure consisting of a Headquarters unit to coordinate all program activities and partner marine institutions distributed throughout the country to conduct laboratory and field tests in a variety of marine environments and regional outreach.

CSC launched ACT in 2000 through a Cooperative Agreement with the University of Maryland Center for Environmental Science Chesapeake Biological Laboratory (CBL). ACT is structured around a small number of Partner marine science institutions located throughout the U.S. The ACT Partners are strategically located to permit concurrent verification of diverse sensor applications across a wide range of coastal environments, including estuaries, bays, shorelines, continental shelves, coral reefs, and the Great Lakes and/or environmental conditions, e.g., freshwater to open ocean, tropical to high latitude seas. Also, the geographical diversity of the ACT Partners creates greater flexibility for ACT to respond to changing regional priorities and maintain pace with and adapt as new capabilities and technologies become available and facilitates greater direct access and participation of a broader group of stakeholders in ACT functions.

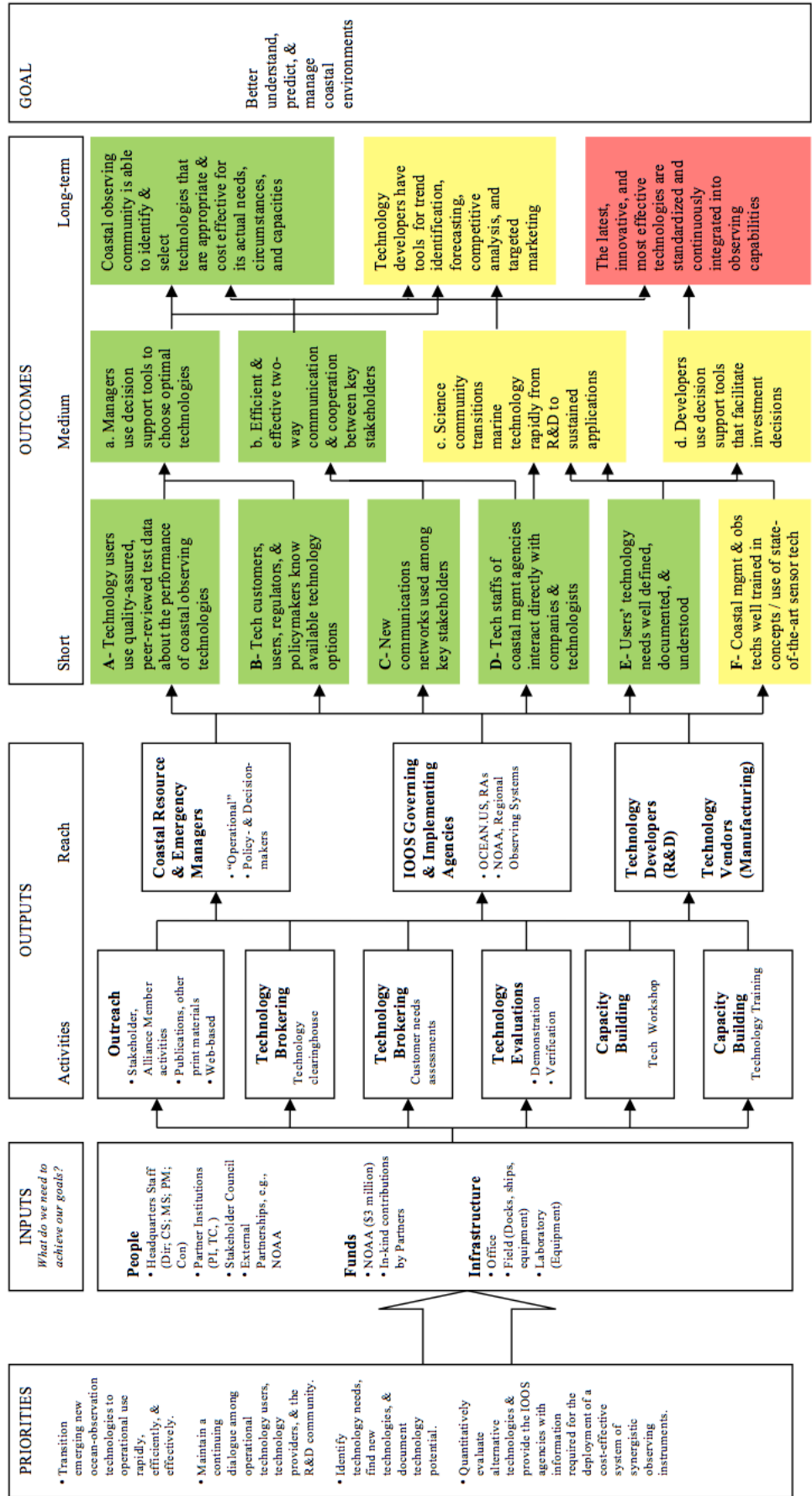
**Table 1. Timeline of Significant Milestones**

Year	ACT Milestone
1997	NOAA Coastal Services Center (CSC) awards contract to Eagen McAllister Associates, Inc. (EMA) to provide a concept and recommendations for a Technology Test-bed Program.
1998	EMA recommends a testbed be organized as collaboratory of geographically distributed, networked marine science laboratories.
1999	Workshop: "An Ocean Observing System for U.S. Coastal Waters: First Step" held May 23-26, in Solomons, MD.
2000	September - NOAA CSC awards Cooperative Agreement to UMD UMCES CBL to establish ACT.
	GoMOOS, SIO, USF, MLML/MBARI become ACT Partner Institutions with CBL. October - Workshop "Targeting Technology Needs of Coastal Managers" provides initial guidance for ACT programs.
2001	November - NOAA appropriated FY2002 funds for ACT.
2002	January – ACT HQ hires full-time Chief Scientist.
	March - First Technology Workshop held on <i>Biosensors for Harmful Algal Blooms</i> .
	ACT becomes host for CSC-developed <i>In-situ Sensors, Platforms, and Telemetry for Coastal Water Monitoring</i> database. Alliance Member outreach activities initiated.
2003	May - CILER, UH become ACT Partner institutions.
	ACT integrated into NOAA CSC Coastal Observation Technology System (COTS).
2004	May - ACT conducts first Technology Verification on DO sensors.
2005	May - UAF/ASLC becomes an ACT Partner institution.
2006	Over 1200+ stakeholders participate in ACT workshops and Alliance Member activities.
2007	May - ACT annual funding cut 60%. ACT reduces number of test sites for technology evaluations; cuts proposed Technical Workshops by 50%; terminates Alliance Member outreach activities, and cancels proposed technology training activities.

Year	ACT Milestone
	July - The Ocean Research and Resources Advisory Panel (ORRAP) report “Best Practices for Increasing the Impact of Research Investments” identifies ACT technology evaluations.
2008	<p>March - OceanSensors08 workshop, Warnemünde, Germany held; consensus cites ACT as an important facilitator to assess sensor performance.</p> <p>May - Administration of ACT Cooperative Agreement moves to from CSC to IOOS Program Office.</p> <p>Two Technical Workshops conducted.</p>
2009	<p>March – ACT partners with the U.S. Army Corps of Engineers (USACE) and the NOAA National Data Buoy Center (NDBC) to develop and publish <i>A National Operational Wave Observation Plan</i>.</p> <p>May – GoMOOS and SIO dropped as ACT Partner institution.</p> <p>September - ACT assists IOOS office in development a five-year, national build-out effort of HF radar systems. <i>A Plan to Meet the Nation’s Needs for Surface Current Mapping</i> published.</p> <p>September – OceanObs09, Venice, Italy. Initial draft of proceedings (12/07) includes recommendation to increase support for technology verification of in situ instrumentation; expand ACT.</p> <p>No Technical Workshops conducted.</p>
2010	May – ACT receives \$3.5M in FY2010 Congressionally-directed funds.
2011	<p>April - ACT Program Evaluation conducted.</p> <p>May – ACT funding reduced.</p>

A workshop held at CBL in October 2000 initiated a broad based stakeholder process to identify priority products and services. The four-pronged strategy for technology transition included 1) verifications of commercial-ready and commercial technologies and demonstrations of prototypes; 2) cross-sectorial, technical workshops and customer needs assessments to assess the current state-of-the-art in technologies; 3) an online searchable database of available technologies; and 4) outreach, including web-based media and Regional Alliance Member chapters. The latter was a larger stakeholder organization that was created to foster the interactive flow of information and ideas among a broad range of user groups and disciplines. The ACT Logic Model (Figure 1.), developed in 2006, visually represents the program elements and linkages between those elements and: priorities, resources, activities, outputs, and short-, medium-, and long-term outcomes. (Note: green boxes indicate accomplished, yellow indicates partially accomplished, and red indicates not accomplished; as determined by this program evaluation).

Figure 1.  
ACT Logic Model.



## ACT Funding and Program Activities

ACT has received the major part of its funds from NOAA since its inception. Funding was administered through a cooperative agreement with the NOAA CSC from 2002 to 2007. In 2008, the responsibility for program management was transferred to U.S. IOOS. The initial financial award of \$500,000 was from CSC base funding. Authorized funding for ACT was approximately \$2.6 million per year of Congressionally-directed funds from 2002 to 2006 (Figure 2).

Program data over this five-year period show that ACT conducted 33 workshops, with over 900 participants (Figure 3), and 79 Alliance Member functions, with over 2,500 individuals attending these events (Figure 4). Technology evaluations began in 2004, when ACT conducted a verification of 4 commercial dissolved oxygen sensors in moored applications at seven Partner sites (Figure 5). Evaluations of one instrument class per year have followed in subsequent years.

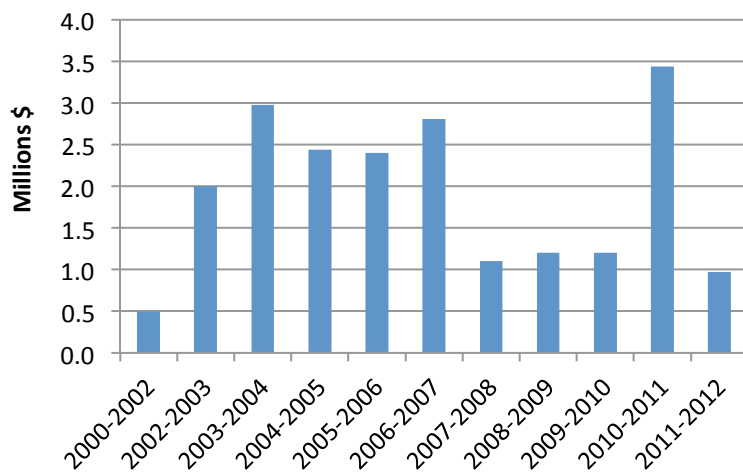


Figure 2. ACT Funding

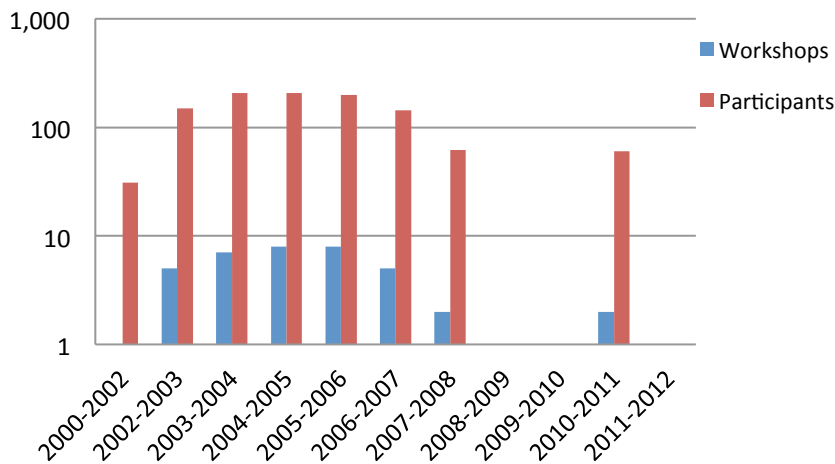


Figure 3. ACT Workshops

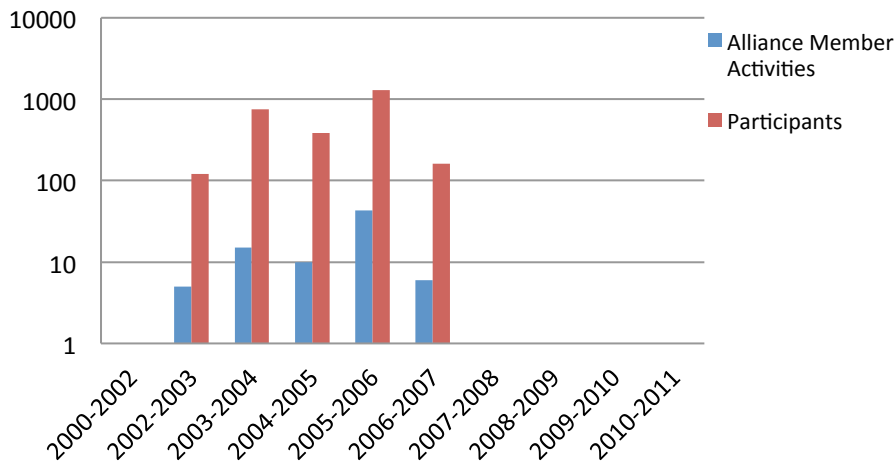


Figure 4. ACT Alliance Members

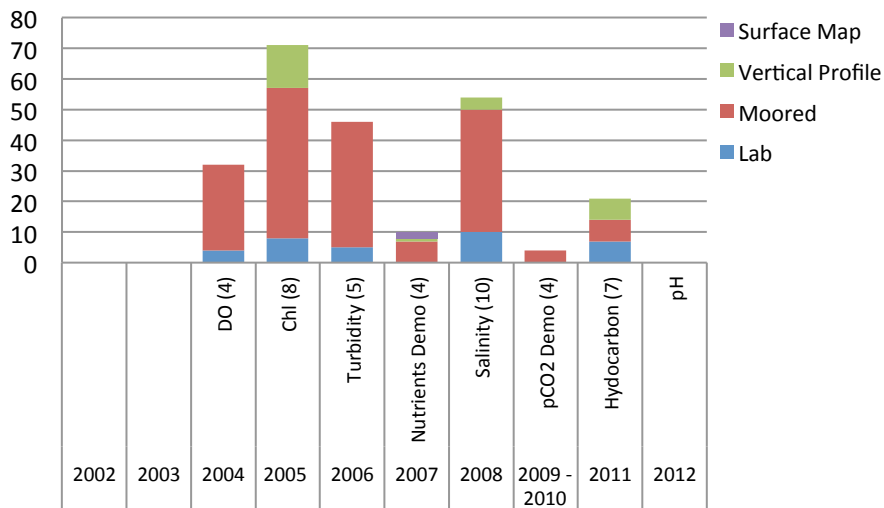


Figure 3. ACT Technology Evaluations

In 2007, NOAA funding for ACT was cut over 60%; and has remained at approximately \$1.1 million in following years with the exception of 2011 when Congressionally-directed funds were added to NOAA's Fiscal Year 2010 appropriations for sensor testing. After the budget reduction, funds were not sufficient to cover the costs of the full suite of ACT products and services. ACT determined to continue the technology evaluations, but as a result the number of workshops was cut, and ACT terminated the Alliance member activities. Outreach was limited to maintaining the ACT web site. While face-to-face communications were drastically reduced, website traffic has remained high. Web traffic for the period March 1 – June 18, 2011 (110 days) is shown in Table 2. Data were provided by Google Analytics. ACT estimated that statistics could be 50-100% higher if data were included from all search engines.

**Table 2. ACT Website Statistics, March 1 – June 18, 2011**

Web-site Traffic Data	
The number of visitors	18,643 (169 visits/day)
Unique visitors	15,638 (84%)
Return visitors	3,005 (16%)
Page views	41,663
Average page views / visit (indication that the average visitors go deep inside the site)	2.3
Average visit duration	1 minute, 50 seconds
Top country of origin of visitors	U.S. 5,658; U.K. 1,042
Top states of origin of U.S. visitors	CA: 707; MD: 696
Total number of reports downloads	34,863

### **Evaluation Context and Objectives**

This report presents the results of the evaluation of ACT, which was conducted, from April 14 – June 30, 2010. While the evaluation did not cover a specific time period, it is important to note that it followed a period of nearly years of reduced ACT funding and activities.

The purpose of the evaluation was to acquire critical information to the ACT Board of Directors to support strategic decisions on ACT's future directions, such as what products should be continued to be offered, what new products should be introduced, and what features should be included in continuing or new products. The issues addressed were relevance, credibility, delivery, and usefulness. The specific objectives were to:

1. Document the information requirements for coastal managers and companies for developing and adopting technological innovation for coastal monitoring and assess the relevance and utility of ACT products to these requirements.
2. Determine how technology claims gain authority and credibility with coastal managers and whether ACT products meet their standards for quality and certainty in decision-making.
3. Document how information on innovative coastal monitoring technologies and other coastal problem solutions are shared by coastal managers and technology companies and assess ACT's means of delivery for its products in this context.
4. Determine to what extent ACT products are being used for decisions on technology choice.
5. Conduct a descriptive comparison and analysis of ACT and similar coastal/environmental testing programs, examining both similarities and differences in core processes, i.e., the steps and procedures that govern how resources are used to create products and services that meet the needs of customers.

A matrix identifying the full set of questions addressed by the evaluation is provided in Appendix I.

## METHODS

Three data-collection efforts were undertaken to address the evaluation objectives: 1) semi-structured interviews with ACT stakeholders, 2) review of relevant literature and official documents; and 3) a site visit to the NOAA NOS CO-OPS OSTEP program office in Chesapeake, VA.

The primary data collection tool was semi-structured, individual interviews with ACT stakeholders. A semi-structured interview is flexible and allows for conversational, two-way communication. The interview questions can be tailored to the context of the person being interviewed, and new questions can be brought up during the interview as a result of what the interviewee says. An interview guide provided the framework for keeping the interviews focused on the topics of interest. In most cases, different stakeholders were asked the same questions to facilitate the comparison of responses and points of view.

Over 60 requests for interviews were sent to ACT stakeholders. Thirty-five interviews were conducted with representatives from 14 different ocean instrument companies and 21 technology users from Federal and non-federal agencies, universities, and other organizations (Table 3). Interviews lasted between 30 and 50 minutes. Of the total, 67% had participated in an ACT workshop, technology evaluation, or both. All but one of the company representatives had taken part in an ACT-sponsored program. Of the non-Federal users interviewed, three were Directors of IOOS Regional Associations. The Federal participants came from 5 laboratories in three different agencies.

Neither the selection process for interviewees nor the responses to the interview questions provide the basis for an objective, statistical analysis of how coastal managers and companies use and value ACT's products. However, given the nature of the issues being discussed and the need to ensure that the views of a broad range of stakeholders were obtained, the flexibility of semi-structured interviews greatly outweighed the limitations on statistical analysis that would result from other survey methods. So semi-structured interviews were chosen in order to allow the interviewees a degree of freedom to explain their thoughts and to highlight areas of particular interest and experience, as well as to enable certain responses to be questioned in greater depth, and in particular to bring out and resolve any apparent contradictions.

**Table 3. General Characteristics and Distribution of Interviewed Stakeholders.**

Total Interviews	Technology Provider		Technology User			
	Participated	Not participated	Non Federal		Federal	
			Participated	Not participated	Participated	Not participated
35	10	0	3	6	5	3

The NOAA NOS CO-OPS Ocean Systems Test and Evaluation Program (OSTEP) and the U.S. EPA's Environmental Technology Verification (ETV) Program were chosen for the comparative analysis with ACT. All three programs have similar mission statements and share certain objectives, requirements, and process, but there also are differences in some basic program elements, such as stakeholder and vendor participation and testing environments. The comparative analysis included a systematic review of documents of all three programs, somewhat analogous to a "desk audit." In addition, a site visit was conducted to the OSTEP offices in Chesapeake, VA, for interviews with CO-OPS and OSTEP staff and a tour of OSTEP facilities.

Secondary data for the evaluation was collected from a number of different sources, including:

- Official ACT, NOAA, and ETV program archival documents (e.g., proposals, proposal reviews), publications, and reports.
- Reports of blue ribbon commissions, such as the U.S. Commission on Ocean Policy (2005), Ocean Research and Resources Advisory Panel (2007), and the NRC Ocean Studies Board (2011).
- Journal articles, surveys, and other literature on the needs of coastal managers, ocean industries, and technology transfer.

## FINDINGS

The findings summarized below reveal how coastal managers gather and evaluate information on technology today, how companies advance new technologies, and how ACT is contributing to these processes as identified through the stakeholder interviews and the review of relevant literature and project documents. Recommendations then follow about how ACT may contribute more to information sharing on technological innovation.

### Are ACT Activities Relevant?

Results from the interviews indicate that ACT’s technology evaluations and workshops are relevant to both coastal managers and companies for technology development and acceptance (Table 4). Both groups gave a high level of importance to: 1) third party evaluations of the performance of available and new coastal observing instrumentation, and 2) opportunities for peer-to-peer, cross-sector, and multi-disciplinary networking. Researchers, on the other hand, tend to believe that peer reviewed laboratory and field experiments by individual scientists is the preferred way to “promote innovation while shielding the operating system from unproven or immature ideas.”

**Table 4. General responses to relevance questions.**

Question	General Response
<b>Is ACT doing the right things?</b>	96% of the respondents said yes. Several “blue ribbon” panels note the importance of technology verification.
<b>Are ACT activities the right activities to meet your current needs?</b>	96% of the respondents said partially. All agreed on the need for more follow-up on practical “know-how,” preferably with a human interface.
<b>Are you aware of other programs that conduct similar activities and provide similar products as ACT? Do ACT’s activities complement or duplicate these programs?</b>	82% of those interviewed said they were aware of other similar programs. This entire group felt that ACT was mostly complementary with these programs.
<b>What products would be available to you in the absence of ACT?</b>	Example responses included university experts, conferences, professional journals, and customer feedback, but generally deemed less important.

Coastal managers recognize the need to learn about and apply new monitoring technologies to solve increasingly complex problems. However, managers are risk-adverse with respect to adoption of new or unfamiliar technology. One clear message from the conversations with coastal managers during this study is that vendor-generated data is viewed with skepticism. For managers, third-party unbiased information

on technology performance is highly important, and ACT technology evaluations produce important information on instruments of interest. Reports from well-established research centers such as the ACT Partner institutions, instills some confidence in the information. Nevertheless, managers indicated they still felt a need to establish credibility elsewhere, usually from an expert they knew and trusted. This was particularly the case when a manager was previously unaware of ACT.

All of the interview companies who had participated in an ACT technology evaluation said that the experience was positive. Also, in all cases, the vendors thought ACT was worth the time and money spent. Prior to ACT, there was no third-party evaluation of their technologies. Most testing is done in-house. On some occasions, field testing is done in collaboration with a research customer. However, problems with this approach include: 1) quality control and quality assurance procedures are often not as rigorous as ACT; and 2) data may not be publicly available until after the researcher has published.

Nearly all the respondents stated that ACT workshops were valuable opportunities for information exchange, expand networks, increase collaboration across sectors, and improve understanding of state-of-the-art technologies. Managers unanimously agreed that recent workshops covered priority topics of interest.

The interviews revealed a contradiction in the way the respondents envisage ACT verifications. Although the vast majority of respondents agreed that ACT technology verifications were relevant to IOOS needs, less than one-third felt like the evaluation reports were adequate as stand-alone products for their direct use. The most often stated need was more practical, “how-to” knowledge on instrument use and data interpretation to accompany the reports. One manager stated, “Knowledge *about* is not knowledge *how*.” Suggestions included special tutorial sessions at conferences and an on demand available, quick response expert service. One vendor noted that an instrument tested in 2005 was no longer manufactured, and suggested that the evaluation reports be periodically updated with information on newer models.

When asked if they were aware of programs similar to ACT, 82 percent of the respondents mentioned the NOAA National Ocean Service Center for Operational Oceanographic Products and Services (CO-OPS) Ocean Systems Test and Evaluation Program (OSTEP) and the U.S. EPA’s Environmental Technology Verification (ETV) Program. They unanimously agreed that the programs were different in several key attributes and complementary. These key differences and similar “best practices” are discussed in more detail in the comparative program analysis findings below.

The most common responses to the question about what products on technology innovation and performance would be available to them in the absence of ACT were scientific and professional journals, Sea Grant extension bulletins, and internet-based resources, such as manufacturers’ websites. Generally, these were considered of less importance than “talking with friends.” Several managers felt that ACT products were unique, and there currently were no substitutes for their content.

The interview results corresponded with recent studies on ocean technology innovation and transfer. Isern and Clark (2006) note that until recently, the vast majority of innovations in ocean instrumentation emerged from federally-funded academic research. The amount of time required for important technical innovations to mature was often paced more by the science enabled than by the innovation itself. Reports of several “blue-ribbon” commissions clearly document the relevance and need for more rapid and efficient transition of instruments and platforms from research to operations:

“In both the federal and academic arenas, it is difficult to incorporate rapidly changing technology into ongoing activities. However, to provide the public with useful information and products, the science community must learn how to rapidly transition marine technologies from the research and development stages to sustained applications.”  
The U.S. Commission on Ocean Policy (2004).

ACT's technology evaluations and workshops are specifically identified by the Ocean Research and Resources Advisory Panel's Research to Applications Task Force as examples of practices that have been useful in facilitating this type of transitioning:

"The user community is most likely to adopt new approaches and technologies when there is broad cross-agency consensus that they are applicable and mature... In some cases, syntheses require evaluation studies to establish the state of science or the relative performance of competing technologies. The studies should encompass efforts by both the public and private sectors and assure broad participation. The evaluation studies conducted by the Alliance for Coastal Technologies (ACT) are a good example of the positive impact of this model."

"ACT workshops, in which representatives from all of these sectors are brought together in equal numbers to explore existing needs, assess the current state-of-the-art in the science, and delineate current commercial solutions. ... serve to create solid foundations for determining "next steps" in transition and adoption of new capabilities." (Weisberg, et.al., 2007).

A recent NRC Ocean Studies Board report entitled "Setting Priorities for Ocean Infrastructure Investments: Critical Infrastructure for Ocean Research and Societal Needs in 2030" (National Academies Press, 2011) states:

"...there is a fundamental need to verify and validate the performance of new and existing instrumentation. Enabling organizations that facilitate the development and adoption of effective and reliable sensors and platforms for ocean science will continue to be needed in the future. These types of organizations (e.g., the Alliance for Coastal Technologies) can provide technology users with an understanding of sensor performance and data quality and provide technology developers and manufactures with opportunities for beta testing, system validation, and insights into various user needs, applications, and requirements through independent laboratory and field testing of prototype and off-the-shelf instrumentation."

"Best practices for encouraging the next generation of ocean infrastructure include... supporting refinement and validation of prototype technologies, building user awareness, and promoting early opportunities for commercial exploitation (e.g., through efforts like the Small Business Innovation Research Program, the Alliance for Coastal Technologies, or the Environmental Protection Agency's Environmental Technology Verification program)."

### **Are ACT Products Credible?**

Every coastal manager and company representative interviewed who had participated in an ACT workshop or technology evaluation considered ACT to be a credible source of information on specific ocean parameters and instrument performance (Table 3). Additionally, these individuals frequently referenced ACT as a credible source when contacted others who were seeking information on technologies, but who were not aware of ACT. The interviews with several researchers suggested that this level of credibility may not be as pervasive in the academic scientist community.

**Table 5. General responses to credibility questions.**

<b>Question</b>	<b>General Response</b>
<b>How do you make judgments about the credibility of information on new technologies?</b>	100% of the respondents said they use multiple indicators, e.g., reputation of the source of information (individual/ institution), level of peer-review, & endorsement by known credible sources.
<b>Do ACT products meet stakeholders' standards for scientific and technical quality?</b>	89% indicated that ACT's reports meet their quality standards. Some respondents questioned the level of peer review.
<b>Do you plan to use new ACT products for technology decision-making?</b>	74% of the interviewees (100% of the vendors) have or plan to use ACT products as part of the suite of information they use.
<b>Does ACT have the right people engaged in its activities?</b>	95% of the respondents who had participated directly in an ACT activity feel that ACT has the right in-house expertise and involves the most knowledgeable experts in its activities.
<b>What other strategies should ACT use to enhance the credibility of its products</b>	15% of the respondents said ACT should improve its peer review process. One review suggested that ACT avoid testing complex technologies.

With managers and companies, while reference to peer-reviewed publications or reports from well-established research centers, instills some confidence in new information, they usually establish the credibility of the information from a trusted expert within an established communication network or informal consensus among peers. There is a general belief that “third-party certifiers” are a good source of performance information for technology purchasers. ACT’s involvement of industry leaders and well-respected managers and scientists in its workshops lends credibility to the information in the workshop reports. Similarly, the advisory panels of diverse and independent managers and scientists that ACT uses to guide its technology testing and to peer review the test results are a valuable factor in acceptance and use of ACT technology evaluations by managers and companies.

From the viewpoint of those within academia, credibility is typically based on the reputation of an individual for consistently performing high-quality science and other yardsticks such as academic appointments, publication record and various citation indices, and awards and honors. One researcher interviewed stated that ACT reports are “difficult to assign to a proper category in the continuum from peer reviewed to partisan opinion,” and that while some colleagues were comfortable in citing ACT reports, others would dismiss the reports saying “that’s their opinion.” The respondent was not aware of the ACT advisory panels and their peer review function. Another researcher interviewed indicated that ACT may be “well-suited for testing some technologies, such as pH, but that it may be overly ambitious in considering testing more sophisticated technologies.”

The main message is that ACT’s products meet the scientific and technical quality standards of managers, companies, and scientists who have participated directly in an ACT workshop or evaluation and who are familiar with ACT’s practice of conducting peer review of its products by qualified individuals who are independent of ACT. ACT participants would use ACT products for technology decision-making. As “champions,” they also are the best, most meaningful avenue for ACT to increase its credibility, incrementally, to a broader audience of stakeholders.

The interviews with researchers indicate that ACT has not adequately communicated to stakeholders, particularly in academia, of its use of peer review to ensure to others that its evaluations are technically

sound, competently performed, properly documented, and satisfy established quality requirements. The interviews also suggest that ACT find meaningful ways to contribute to the scientific and/or technical body of knowledge that supports its work.

### **Does ACT’s Product Delivery System Promote Stakeholders’ Learning and Skills?**

Based on the interviews, it is clear that ACT’s product delivery system does not provide all the information about innovations and best practices that coastal managers say they need, when and how they want it (Table 4). ACT’s existing system to communicate its products and services needs to be transformed to provide this information.

Coastal managers use a wide range of sources when they need to look elsewhere for innovative practices and solutions to problems. It is very much a demand driven, ad hoc, and often hit-or-miss process, constrained by available knowledge and skills. Managers acknowledge the importance of the internet as a resource for learning and source for information and data. However, the most cited source for new information was learning from others who have had to deal with similar issues, and adapting that experience to their own situation. Managers were most frequently bothered by not being able to find information about how others dealt with a problem.

**Table 6. General responses to product delivery questions.**

<b>Question</b>	<b>General Response</b>
<b>How did you learn about ACT?</b>	Almost all the respondents learned about ACT either through invitation to an ACT workshop or referral from a colleague. One person learned about ACT when contacted to participate in the program evaluation. Internet search engines did not play a role.
<b>Are you aware of ACT’s products? Are they easy to find?</b>	96% of the respondents were aware of ACT products. Less than 25% felt they were easy to find.
<b>Are they being delivered in a way that you can use them?</b>	44% indicated that ACT product delivery was satisfactory.
<b>Do ACT reports have the right content? Are they well written and understandable?</b>	Almost 75% of the respondents said that ACT reports have the right content. 93% said they were well written and understandable.

Approximately 75 percent of the respondents had no knowledge of ACT until they were either contacted directly by ACT staff to participate in an ACT activity or heard about ACT from a colleague. Although most of the interviewees had participated in an ACT activity and were aware of ACT’s products, less than a quarter of the group felt they were easy to find and more than half felt ACT’s delivery system needed to be improved. However, as demonstrated in Table 2, the ACT website is visited (and reports download) by consistently over 100 people per day, from around the world.

Delivering information in a way that has the most impact on a manager is a communications problem. Many interviewees felt like ACT “vanished” after a report was made available on its web site. The most frequently cited complaint was the lack of follow-up from ACT. They are awash with information delivered to their computers, whether they want it or not, and do not have the time to sort through it. Specific, focused, and personalized communications are thought to be effective means to inform them about new techniques and applications.

## Are ACT's Products Being Used?

Technology developers and providers that participate in ACT verifications use the information to improve their technologies in terms of enhanced performance, reductions in production costs, or both (Table 7).

Three managers indicated that they used ACT verification reports for technology selection:

- Chlorophyll probes on real-time buoys deployed by USEPA in two New England watersheds to track of cyanobacteria blooms had poor correlation with analytical laboratory data. The ACT verification reports on fluorometers were used in the agency's formal approval process to deploy an alternative sensor.
- An IOOS Regional Association (RA) Director uses ACT verification data to select instrumentation for RA-funded projects.
- ACT verification reports on salinity sensors were used by NOAA OSTEP to pre-screen technologies for further testing.

**Table 7. General responses to product use questions.**

Question	General Response
<b>Have you used ACT information to make technology advancement and use decisions?</b>	All of the vendors who have participated in an ACT verification use the information to make improvements to their products. Three managers used ACT verifications to support technology selection.
<b>Are you doing anything differently in your day-to-day work as a result of ACT products?</b>	Over half of the interviewees said that ACT had little impact on their routine responsibilities. Some smaller companies use ACT verifications as part of marketing their products.
<b>What would you lose if there wasn't an ACT? How would you make technology development and use decisions without this information?</b>	Companies value access to multiple test sites and expertise. In-house testing would be used, but is a longer process. Both managers and companies noted loss of networking opportunities. Managers would rely on talking with colleagues and friends.
<b>What hurdles remain?</b>	The most common hurdles identified by managers included lack of: "how-to" knowledge, documentation of best practices, training, and resources.
<b>What other types of products and activities should ACT be doing? (What should ACT be doing that it's not doing?)</b>	<ul style="list-style-type: none"> <li>• Establish an all-purpose, real-person information source for best practices.</li> <li>• Hold special "how-to" tutorial sessions at conferences.</li> <li>• Conduct joint activities with NOAA field laboratories, e.g., hold work at NOAA lab, use NOAA sites/personnel to assist in verifications.</li> </ul>

None of the people interviewed thought they were doing anything different as a result of ACT, either because it is difficult to attribute such changes to a single source, or because ACT truly had no impact at this level. Companies noted that they may use ACT verifications in their marketing to gain recognition and credibility.

Despite this, almost all the respondents declared that participating in ACT activities was worth the time and money spent. Companies cited the access to well organized, multiple-site testing for their instruments as very important, and most noted they lacked the financial resources to conduct similarly scaled evaluations. Several persons indicated that rapid access to large datasets on their instruments' performance accelerated improvements. Both managers and companies valued the networking opportunities provided by ACT workshops. Managers would continue to use a variety of sources for information, including contacting known experts. Regarding the latter, they recognize that knowledge is assembled in groups such as ACT. Some of the respondents said they had observed that experts often attach themselves to or become associated with a particular technology and that competitive situations may arise between experts.

When questioned about what barriers and constraints still need to be overcome, the most frequently cited were information overload, limited human and financial resources, increased workload demands, limited technical capacity, and leadership that discourages risk taking. Additionally, the time it takes to become aware of and learn how to use a new technology can be prohibitive.

The importance of human interaction was the most pervasive theme in all the suggestions for other types of activities ACT should do.

Several respondents suggested ACT establish a "consulting service" that would provide all-purpose information on innovative technologies to help managers assess their needs and evaluate options. The service would be linked to real people and be available in real time when a coastal manager needs it. A starting point could be the development of an Ocean Expert database, similar to the IOC's directory ([www.oceanexpert.net](http://www.oceanexpert.net)), but with some human interface features.

Another suggestion was that ACT routinely sponsor tutorials on "how-to" and "what does it mean" on specific technologies at conferences such as the annual MTS or bi-annual CZM meetings. One RA Director stated, "I would fund technical staff and graduate students to attend something like that."

Some suggested that ACT create a "new partnership" with NOAA to promote cooperation, but in a way that would achieve buy-in and bring explicit benefits to other NOAA programs. One idea was to hold ACT workshops at NOAA laboratories, to allow the laboratories to network and "market" their capabilities to managers and companies. An example would be to hold a workshop on an oceans and human health issue at the Hollings Marine Laboratory in Charleston, SC, rather than at an ACT partner institution. Future workshop sites could rotate among labs, depending on the topic. Joint technology verifications with NOAA personnel or at NOAA sites also was suggested; of particular interest to NWS forecasters in coastal regions are "rapidly-deployed" sensor systems to monitor short-term events.

Similarly, expansion of collaboration with the RAs and university-centered program such as the NSF-funded Ocean Observatories Initiative (OOI). However, several respondents suggested that there may be barriers that would need to be overcome first. With OOI, there is skepticism of the credibility of ACT reports at the individual researcher level. Some of the interviewees felt that ACT would have to overcome the perceptions of some RAs that ACT is a competitor for funds before ACT can effectively collaborate at the national level.

### **How Does ACT Compare with Similar Programs?**

The U.S. EPA's Environmental Technology Verification (ETV) Program and the NOAA NOS CO-OPS Ocean Systems Test and Evaluation Program (OSTEP) were chosen for the comparative analysis with ACT. All three programs have similar mission statements and share certain objectives, requirements, and process. The comparative analysis included a systematic review of documents of all three programs, somewhat analogous to a "desk audit." Telephone interviews were conducted with EPA ETV and CO-

OPS staff. In addition, a site visit was conducted to the OSTEP offices in Chesapeake, VA, for interviews with CO-OPS and OSTEP staff and a tour of OSTEP facilities.

### EPA ETV

The U.S. EPA's Environmental Technology Verification (ETV) Program was launched in 1995. The objective of this pioneering program is to provide credible performance data for commercial-ready environmental technologies so as to aid vendors in selling innovative technologies and regulators and purchasers in making their decisions. The program is structured around a small number (six in 2011) of specialized verification organizations (VOs). EPA has a dedicated EPA program office with the overall responsibility to ensure scientific relevance, fairness and consistency across partner organizations. The program is open to all vendors of commercial-ready environmental technologies, both domestically and internationally. A stakeholder process helps choosing technologies, developing testing protocols and approving verification reports. The VO tests the equipment using the procedures outlined in a test/quality assurance plan developed in concert with the EPA, vendor, and stakeholders. The deliverables of the program include testing protocols and verification reports containing data on environmental performance. As of May 2011, ETV has verified over 440 technologies and developed more than 90 protocols. ETV does not compare vendors by name but technologies may be compared to standard reference procedures or technologies if appropriate. The technology vendor is solely responsible for outreach activities related to the performance verification of their product. However, companies and products that have been verified by ETV are posted on the ETV Web site.

EPA funding for ETV from 1995 to 2004 was over \$63 million to establish the ETV centers infrastructure, to develop protocols for testing, and to support testing. Funding for the program was discontinued in FY 2007. However, EPA has continued to fund the operation of the ETV office at approximately \$500,000 per year since 2008. Funding for verifications is leveraged from a variety of sources, including other EPA programs, other agencies, and vendors.

When the program was being set up (through 2005), the costs of a verification or protocol averaged about \$120,000. These costs include the following cost elements: technology solicitation and selection, development of technology specific test and quality assurance plans, technology testing, quality assurance and evaluation and development of verification reports and statements. In addition, VO center support costs vary between 20 and 35 % of the total test cost (approximately \$50,000). These costs include stakeholder activities and meetings, development and maintenance of the quality management system, evaluation and outreach, and other general and management costs. While these activities are "accessory" to actual technology verification, EPA considers them necessary for the good functioning of the system. Costs for the verification per vendor range between \$20,000 and \$100,000 each, depending on the complexity of the test.

### NOAA CO-OPS Ocean Systems Test and Evaluation Program

The Ocean Systems Test and Evaluation Program (OSTEP) was established in 2001 within the National Ocean Service (NOS) Center for Operational Oceanographic Products and Services (CO-OPS). CO-OPS provides the infrastructure and technical expertise required to manage the National Water Level Observation Network (NWLON), a national network of Physical Oceanographic Real-Time Systems (PORTS®) in major U.S. harbors, and the National Current Observation Program. Operation of these end-to-end systems includes documenting user requirements; establishing standards for water level and current data collection; designing new measurement systems; designing new data processing software; performing operational data analysis/quality control; and producing and disseminating oceanographic products from the systems.

OSTEP evaluates new sensor technologies primarily to increase the capabilities, efficiencies, utility, and accuracy of the NWLON and PORTS® operational systems. The program has a small core staff based at the CO-OPS Field Operations Division (FOD)/Atlantic Region Office in Chesapeake, VA. However, OSTEP may draw upon all CO-OPS resources and other NOAA offices for sensor evaluations. The sensors selected for evaluation are either requested and supported in part by PORTS® partners, or chosen by CO-OPS based on potential for enhancing the NWLON. CO-OPS and OSTEP staff conduct an initial assessment of commercially-available sensors, and those determined to best meet CO-OPS systems' basic requirements are evaluated under laboratory and field conditions. OSTEP field tests evaluate the new instrumentation integrated into an operational setting to determine readiness for deployment and define the operations and maintenance lifecycle of the system, including sensors, data communications, and data collection/acquisition software and hardware. Data quality assurance must meet standards required for NOS to accept legal liability for observations and derived navigation safety products and services. OSTEP deliverables include reports of sensors' performance, data sampling and processing methodologies, quality control procedures, and installation and maintenance routines. Although OSTEP does not endorse specific sensors or manufacturers for general applications, OSTEP does recommend NOAA NOS approval of the "best suited" technology and sensor based on quantitative criteria specifically based on CO-OPS' unique operational requirements. OSTEP's primary clients are CO-OPS and its PORTS® and NWLON partners; there is no large outreach component.

The CO-OPS Strategic Plan for 2010 notes that OSTEP growth was "painfully" slow. Evaluations generally are conducted at multiple sites and may be long-term. For example, OSTEP tested 8 different visibility sensors at 5 separate locations over 8 years. Field evaluations of an acoustic Doppler current profilers (ADCPs) manufactured by Nortek were conducted at two sites ranging from 19 days to 4 months. In this case, CO-OPS worked with the manufacturer to make improvements in the technology to satisfy CO-OPS performance and design requirements.

OSTEP technology evaluations are not only highly leveraged within CO-OPS, but also through partnerships with other NOAA offices, port authorities, and universities. Cost elements include procurement, installation, testing, and development of operational use guidelines. A precise accounting of the costs for OSTEP evaluations was not available, and test costs will vary depending on the technology. However, one CO-OPS source indicated that the estimated cost of a recent series of laboratory and field tests on four different microwave water level sensors at four sites was \$1.0 million.

#### ACT Technology Evaluation Cost Elements

The key characteristics of ACT and its technology evaluation process have been described in the Introduction. An analysis of ACT funding and distribution of resources for technology evaluations shows a rise in costs at the beginning, when ACT was being set up, followed by a more or less stable period from 2003 to 2006, followed by a fall in costs linked to a 60% reduction in NOAA funding (Figure 6). After 2003, the funds allocated to technology evaluations have been higher than the combined costs for other ACT program activities and program management, with the exception of 2010- 2011 when ACT received additional funding for several special projects. It should be noted that the in-kind contributions of the ACT Partner institutions and the costs expended by vendors to participate in the evaluation have not been included in the estimate.

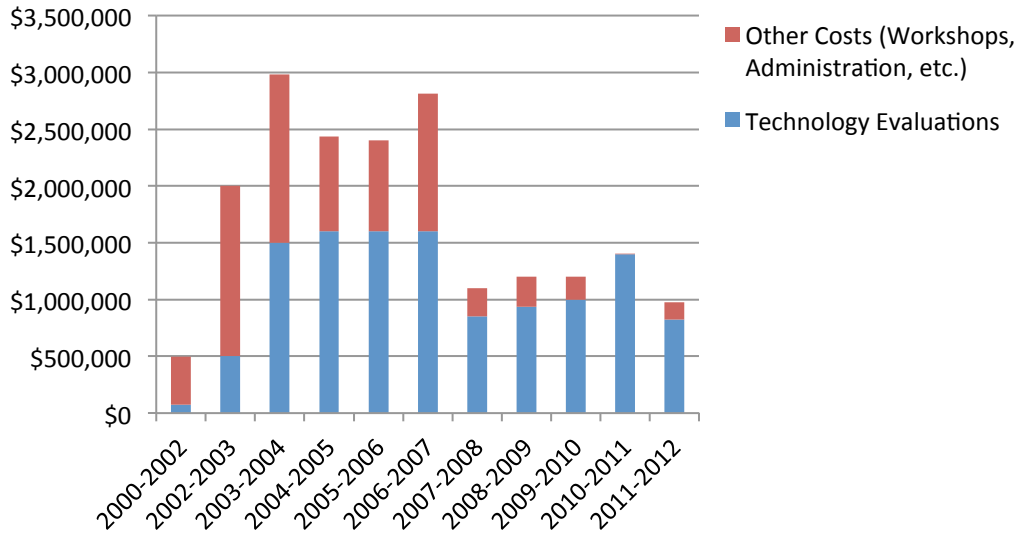


Figure 6. ACT Funding and Distribution of Expenditures

The relative cost distribution for this same period shows that the percent of costs for technology evaluations has been over 50% since the first evaluation of dissolved oxygen sensors in 2003-2004, again except during 2010-2011. The percentage of costs associated with technology evaluations actually increased as NOAA funding decreases, which is a reflection of ACT’s decision to prioritize the technology evaluations and cut back in other areas, such as technical workshops (Figure 7).

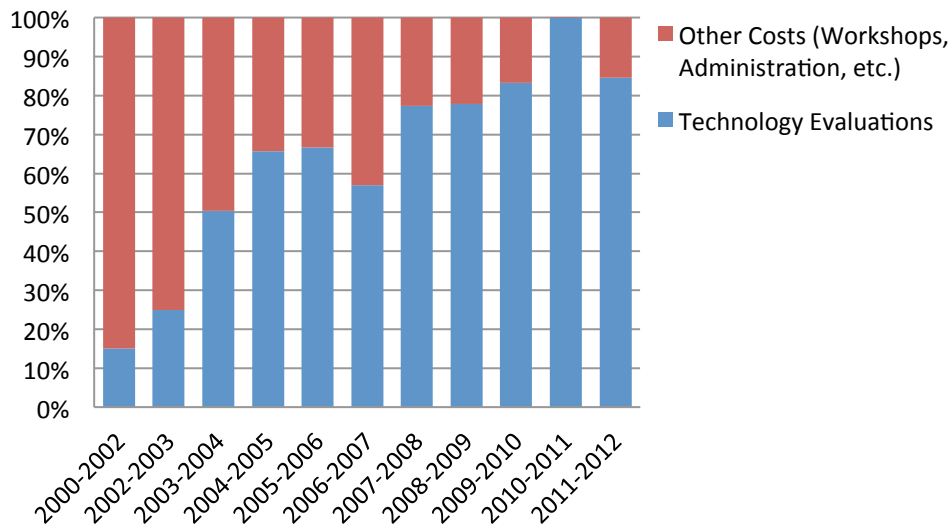


Figure 7. Relative cost distribution of ACT

There are a number of costs associated with a specific ACT test from the point in time when a technology category has been identified and the decision made to pursue the test. Those costs are linked to the following activities:

- Customer needs and use assessment: 15% of the cost;
- Vendor identification and test collaborator recruitment: 5% of the cost;
- Preparation of the test plan: 5-10% of the cost for a single technology;
- Testing: approximately 50% of the cost;
- Data analysis and preparation of test reports: 20-25% of the cost.

The total cost of an evaluation from start to finish may vary widely depending on the technology, the scope of the test, the number of participating vendors, the number of sites and duration of field deployments, and personnel time requirements for setting up and operating the technologies and collecting reference samples. More elaborate evaluations will increase the costs, such as those evaluations which require ship time for vertical profiling and/or third-party laboratory analysis of reference samples. For example, the direct costs of the ACT evaluation of 8 fluorimeters at the University of Michigan/CILER (UM) site in 2005 were estimated at \$130,000, which included moored and shipboard vertical profiling tests. The UM direct cost estimate for the hydrocarbon sensor verification is \$194,000. More sensors are being tested, but at fewer sites. However, the verification requires extensive analytical laboratory services and shiptime, which increases the costs. Overall, the cost range of individual evaluation is \$24,000 to \$166,000 using a simplified formula of the number of instruments and test sites per the total cost of the evaluation.

#### Comparison of ETV, OSTEP, and ACT

The analysis of the three technology evaluation programs - ACT, OSTEP, and ETV – shows that their missions are similar, and that to the extent that they share a number of features at the macro-level of design and implementation, the programs are complementary. The objective of all three programs is to produce credible performance data for environmental monitoring technologies, in general, and for ACT and OSTEP, marine technologies exclusively. Consequently, there are numerous similarities between the programs, in particular requirements for a high level of QA/QC for data collection and analysis. The differences in these programs reflect the differences in the nature and needs of those stakeholders they consider as the primary users of the data and the principal drivers of each program. (Table 8).

Both ACT and EPA seek to aid technology providers and technology users, in particular environmental managers and regulators. ETV encompasses a broad range of environmental monitoring technologies for water, air, and soil, and well as technologies for pollution control and treatment. ACT focuses specifically on sensors for monitoring important ocean and coastal parameters; and coastal resource managers are considered the principal audience for technology performance information. OSTEP focuses on technologies relevant to enhancing the operation of the CO-OPS NWLON and PORTS® and their products.

**Table 8. Program characteristics**

Program Characteristic	ACT	NOAA NOS CO-OPS OSTEP	EPA ETV
Structure	Extramural, federally program funded through Cooperative Agreement	Federal agency program office	Cooperative agreements with private verification organizations
Primary Customers	Coastal managers, coastal/ocean instrument companies; IOOS RAs	NOAA NOS CO-OPS NWLON and PORTS Other international water level monitoring networks, PORTS	Buyers and users of environmental technology, technology developers and vendors, and technology “enablers”
Technology Priorities	Determined by primary stakeholders, including NOAA	Determined by NOAA NOS CO-OPS	Determined by EPA, with stakeholders inputs
Technology Stage	Late-stage development, pre-commercial, and commercial	Commercial	Commercial-ready and commercial
Test Conditions	Laboratory; operational field conditions and application.	Laboratory, field tests integrated into operational systems	Laboratory, representative operational conditions
Evaluation Costs (per instrument)	\$24,000 to \$166,000	\$62,500 - \$100,000	\$20,000 to \$250,000
Cost to Vendor	Provide test instrument, participation in protocol development	None	Application fee, test plan preparation costs, and verification testing costs (75-90% of overall test cost)

An important difference in the programs is the degree of importance of regulatory and legal factors as drivers. The CO-OPS NWLON and PORTS® provide observations and predictions of oceanographic and marine meteorological conditions for decision support in which life and property are at risk. OSTEP evaluations help NOAA achieve a level of “best achievable” quality required for NOS to accept legal liability for observations and derived navigation safety products and services. A prime motivator for participation in ETV is to evaluate a technology’s performance to either meet or monitor regulatory compliance. As a result, the number of verifications conducted by ETV VO’s each year probably is more dependent on regulations which push vendors to get their technologies verified to address compliance than on the level of funding received from EPA each year. However, without federal funding, the VO’s evaluate a narrower range of technologies, developed less and less by small companies, because few of them can afford the costs. Legal and regulatory compliance are not primary objectives for many of the technology developers and suppliers who participate in ACT evaluations. Generally, these are small companies that seek to improve their technologies or have their technologies gain credibility on the market but do not have a lot of financial resources to pay for independent testing. The few larger marine instrument companies may not require ACT evaluation because they are already well known on the market.

OSTEP compares and select technologies based on criteria specifically designed to meet CO-OPS’ unique applications and operational requirements. OSTEP must guarantee these performance criteria are met, in essence, certifying a technology for integration into CO-OPS three operational systems. Neither ACT nor

ETV compares or rank technologies. However, both systems' designs allow comparison, since technologies of the same type are tested under the same condition and resulting data are publicly available.

Another important difference between the three programs is that technology evaluations in OSTEP, and, to a lesser degree ETV, take place "inside" the agency. In the OSTEP evaluation process, NOAA decides, with some stakeholder feedback, the type of technologies, the tests that will be needed, and the operational conditions that will be applied. NOAA staff conducts all phases of the testing. In ETV, in particular under the Environmental and Sustainable Technology Evaluations (ESTE) component initiated in 2005, EPA's Office of Research and Development (ORD), with input from EPA program office and regional offices, choose technology categories for verification. ORD project managers direct the verifications using VO support. In ACT, the Principal Investigators at the Partner Institutions have decided the types of technologies and applications for testing, based on considerable stakeholder consultation. The PIs also direct the evaluations.

Finally, it is important to distinguish each program's position on the research to operations continuum. ACT and ETV are most closely aligned. Both ACT and ETV test technologies under representative operational "conditions." However, ETV evaluates commercially-ready and commercially-available technologies, whereas ACT also conducts demonstrations of late-stage development, pre-commercial, technologies. OSTEP tests commercial technologies integrated into operational systems, the last step to fully "mission capable." OSTEP staff noted that they recently had used the ACT verification of salinity sensors as a "pre-screen" to reduce the number of sensors that they included in their subsequent testing, saving OSTEP "time and money."

## **General Conclusions**

The comparison of the three technology evaluation programs - ACT, OSTEP, and ETV – shows that their missions are similar, and that to the extent that they share a number of features at the organizational-level of design and implementation, the programs are complementary. The differences in these programs reflect the differences in the nature and needs of their primary customers and their positions with respect to within the organization of their primary sponsor, i.e., the lead agency responsible for funding, managing, administering, or monitoring the functions of the program. None of these programs would be viable without federal funding..

A cost-outcome analysis is out of the scope of this evaluation. In addition, there has so far been no comprehensive outcome evaluation of ETV or OSTEP. Also, none of the programs have a precise estimation of the financial elements of a complete technology evaluation that would be required for such an analysis. In any case, a comparison of the costs of individual verifications is of limited value, since they are strongly technology and program specific. Costs also vary with the number of instruments, number of sites, duration of the field deployments, technology application (i.e., stationary platform, shipboard profiling), and the need for external laboratory analyses. Perhaps, the most appropriate way currently to compare ACT, ETV, and OSTEP would be to comparing the results of the program to the program's intended objectives. To this end, program objectives are being attained by all three programs.

## RECOMMENDATIONS

Stakeholders offered a number of recommendations consistent with the evaluation findings:

- **Expand outreach and communications.** Emphasis should be placed on mechanisms to achieve a wider and more effective dissemination of knowledge about ACT and its products to national and international stakeholders.
- **Expand the use of multi-stakeholder interactions as a tool to follow-up ACT technology workshops and verifications.** Priority should be given to develop activities to disseminate procedural knowledge.
- **Ensure that the selection of technology workshops and evaluations is clearly and consistently tied to NOAA IOOS Program priorities and reflect regional needs, in coordination with the IOOS Regional Associations.**
- **Explore opportunities to forge stronger links with other NOAA program offices and other agencies to encourage cross-partnerships for technological advancement of ocean observing and monitoring.** These programs include NOAA/NOS OSTEP, NOAA laboratories, the National Science Foundation Ocean Observing Initiative, and the US Coast Guard.
- **Enhance credibility of ACT products.** Achieve buy-in of the leading experts in relevant fields by engaging them early and often in developing and reviewing ACT projects, in particular the technology evaluations. Improve awareness of ACT's quality systems, including external peer review.

**APPENDIX I.**  
**General Interview Guide**

Topic Area	Interview Questions
<b>Are ACT Activities Relevant?</b>	Is ACT doing the right things?
	Are ACT activities the right activities to meet your current needs?
	Are you aware of other programs that conduct similar activities and provide similar products as ACT? Do ACT's activities complement or duplicate these programs?
	What products would be available to you in the absence of ACT?
<b>Are ACT Products Credible?</b>	How do you make judgments about the credibility of information on new technologies?
	Do ACT products meet stakeholders' standards for scientific and technical quality?
	To you plan to use new ACT products for technology decision-making?
	Does ACT have the right people engaged in its activities?
	What other strategies should ACT use to enhance the credibility of its products
<b>Does ACT's Product Delivery System Promote Stakeholders' Learning and Skills?</b>	How did you learn about ACT?
	Are you aware of ACT's products? Are they easy to find?
	Are they being delivered in a way that you can use them?
	Do ACT reports have the right content? Are they well written and understandable?
<b>Are ACT's Products Being Used?</b>	Have you used ACT information to make technology advancement and use decisions?
	Are you doing anything differently in your day-to-day work as a result of ACT products?
	What would you lose if there wasn't an ACT? How would you make technology development and use decisions without this information?
	What hurdles to you to being able to take action?
	What other types of products and activities should ACT be doing? (What should ACT be doing that it's not doing?)
<b>How Does ACT Compare with Similar Programs?</b>	Are you aware of other programs that test and evaluate ocean instruments?
	Have you ever participated in other technology testing activities?
	How are they similar? Different?

Topic Area	Interview Questions
<b>For Participants of ACT Technology Evaluations</b>	Describe your experience of being involved in an ACT technology evaluation. What was the most satisfying about your involvement? What was least?
	Was the outcome of the verification worth the investment (in terms of time and -money)?
	What was the impact of the verification on your overall business? Did the verification actually accelerate the entrance of your technology into the marketplace?
	Is the verification program well recognized on the market? (By buyers, users, public officials, etc.)? What are the main criteria for ACT to be credible on the market?
<b>For Participants of ACT Workshops</b>	Describe your experience of being involved in an ACT workshop. What was the most satisfying about your involvement? What was least?
	Was the outcome of the verification worth the investment (in terms of time and -money)?