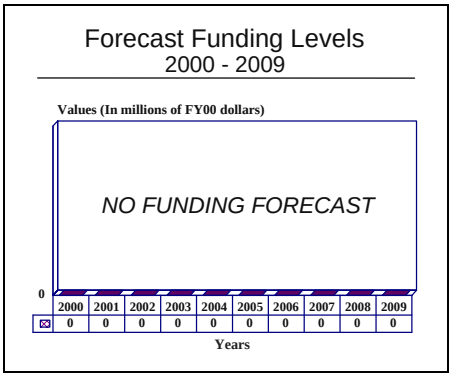
Combat Systems Oceanographic Performance Assessment (CSOPA) - Archived 12/2001

Outlook

- Program consolidated and merged with other existing programs as of FY99; several of these programs are now classified
- Existing contracts to be completed by end of year 2001
- This report will be archived next year, 2001



Orientation

Description. The US Navy's Combat Systems Oceanographic Performance Assessment (CSOPA) program conducted ocean environmental acoustic research and development to predict the performance of current and proposed anti-submarine warfare (ASW) surveillance systems. As of FY99, it was merged into other programs.

Sponsor

US Navy

Naval Command, Control, & Ocean Surveillance Center
RDT&E Division
San Diego, California (CA) USA

Naval Research Laboratory
Washington, DC USA

Naval Research Laboratory Stennis Space Center
Stennis Space Center, Mississippi (MS) USA

Naval Undersea Warfare Center Detachment
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(Project V/X0823)

Status. Research and development. As of FY99, efforts within this program were transferred and merged with other projects.

Total Produced. This was a non-acquisition program.

Platform. Various ASW systems for surface vessels and submarines.

Application. To predict the performance of current and proposed ASW surveillance, tactical and weapons systems.

Price Range. Not applicable.

Technical Data

PE#0603785N Combat Systems Oceanographic Performance Assessment (CSOPA) consisted of three projects:

Project R/X0120 Advanced Environmental Acoustic Support (AEAS). This project provided environmental acoustic predictive capability, and data essential to optimize the design, development and performance of undersea acoustic surveillance and tactical ASW systems. Undersea environmental and acoustic measurements were acquired, and computer prediction products, measurement instrumentation, databases, and analyses were developed in support of ASW systems.

Project R/X2017 Advanced Underwater Acoustic Modeling Project (AUAMP). This project focused on the development of a multi-source, multi-receiver, fully bistatic ASW system performance prediction capability in support of low-frequency, active ASW systems developed for use in the 1990s.

Project V/X0823 Sensor Performance Prediction (SPP). Under the SPP project, onboard software was developed that that could predict sensor performance for all tactical platforms using in-situ measurements, synoptic data and new/updated environmental databases. SPP enhanced the performance potential of complex systems by increasing their detection/tracking performance.

Variants/Upgrades

This section is not applicable to this report.

Program Review

Background. Individual project activities were as follows:

Project R/X0120 Advanced Environmental Acoustic Support (AEAS). The quieting of new-generation threat submarines dramatically reduced the detection ranges of passive acoustic ASW systems. Additionally, the concern over Third World conflicts renewed the need to address diesel-electric submarine and mine warfare issues. To counter these threats, the US Navy undertook the development of active sonar systems for ASW and improved mine detection/avoidance. There is always an urgent need to enhance system performance through a better understanding of the ocean environment. The need to understand that environment is greater for active sonar systems than that for passive sonar systems because of the need to operate effectively in shallow water (a very difficult environment because of repetitive interactions of the acoustic signal with the surface and bottom boundaries), and to receive the signal and detect the target at other receive points separate from the acoustic source (multistatic).

In FY92, system performance in specific environmental areas was assessed for incorporation into emerging Low Frequency Active (LFA) and bottom-laid passive ASW systems design concepts. Modeling and analysis efforts to extend Low Frequency Active Acoustics (LFAA) concepts in the Arctic environment were also supported during this period of initial program development.

Other accomplishments during this time included the following: collecting shallow water Very Low Frequency (VLF) acoustic data in the Grand Banks area to address issues unique to shallow water; extending the Navy standard Low Frequency Bottom Loss (LFBL) model/database down in frequency to include VLF, and using finite difference research code to identify mechanisms to include in long-range VLF upgrades to LFBL; participating in major field experiments in support of ASW system design and operations (i.e., Fixed Distribution System, Air Defense Initiative [ADI], VLF, LFA, SQQ-89 upgrades, Critical Sea Test [CST]); developing mine countermeasures (MCM) prototype products using sediment classifier data and extending the standard prediction model for MCM sonar; and extending the deep water shipping database to shallow water for use as input to the shallow water ambient noise model.

Other accomplishments included the development of volume reverberation vertical line array and transition to NAVOCEANO; test and evaluation of the developmental digital acoustic array and AEAS Digital Acoustic Buoy System (ADABS); initial CDC concept demonstration of real-time in-situ environmental data measurement to optimize system performance; the development of a model to predict time/angle spreads in thin sediments based upon Kirchoff slope scattering; obtaining thin sediment bottom loss data (PAC ECHO 4) to be used for further development of a Frequency/Angle/Time (FAT) spread sheet; and development of a system loss (SYS LOSS) model to account for losses due to the environment.

Accomplishments during FY93 consisted of the following: participation in CST-7 field experiments in support of emerging undersea systems design and operations; the conduct of ocean area assessments via computer modeling and determination of initial survey requirements; processing and analyzing Arctic LFAA data from the FY92 Arctic exercises; support of LFAA reverberation algorithm and model development for Arctic application; analyzing Low Frequency Passive propagation and ambient noise from the FY92 Beaufort Sea exercise, followed by upgrades to the Navy Standard Ice-Capable Acoustic Prediction (ICECAP) propagation model; incorporation of seismic reflectors into LFBL to provide bottom loss at VLF; and continued development of environmental models and databases to enhance shallow water operational capabilities. Additionally, environmental assessment documents addressing high-priority shallow water areas were published.

Numerous other efforts were made in FY93. Among them were the following: models were developed to predict bottom scattering, reverberation and time spreads for shallow water and deep water thin-sediment areas; Acoustic Signal Excess Prediction System (ASEPS) Transition Loss (ASTRAL) was incorporated into the Navy Standard Model; LFBL was extended to active frequencies; the ARPA-developed HF synthetic ocean acoustic environment was expanded to cover higher frequency regimes for use in simulations; and transputer architecture was developed for underwater acoustic models to reduce computation times.

During FY94, the shipboard CDC technology was updated to include surface scattering strength and surface reflection loss. In other work, flight testing of the prototype airborne CDC system was completed; data recording systems were developed for use in measurement efforts off the coast of the United States; an environmental assessment for the Korean waters was completed; and a critical environmental factors atlas for regional conflict scenarios was developed.

Airborne and surface CDC data acquisition technology and signal processing algorithms were evaluated during FY95. In FY96, a virtual acoustic ocean was developed for mid-frequency tactical sonars, Extended Echo Range Sonobuoys, and active Advanced Distributed Systems. Also in FY96, the Amphibious Warfare Tactical Decision Aid was interfaced with meteorological and oceanographic mapping, charting and geodesic sensors, and the performance of mine warfare systems was evaluated in littoral environments.

The MCM tactics and optimization algorithms were finished in FY97, and a minefield planning module was then developed. After the mine warfare system's performance in littoral environments had been evaluated, the amphibious warfare decision aid was linked to the meteorological and oceanographic data distribution network and evaluated at-sea. The virtual acoustic ocean development was completed during FY97. Once this had been accomplished, a virtual atmosphere was developed for use in simulating the radar systems used for theater anti-missile and air defense.

In FY98, the temporal/spatial variability of littoral environments was assessed. The agenda for FY99 called for continuing the work initiated in FY98 under the Air/Ocean Tactical Applications program.

Project R/X2017 Advanced Underwater Acoustic Modeling Project (AUAMP). As Navy sonar systems

became more sophisticated and their use in shallow water increased, the need to understand underwater sound boundary interactions and propagation through the oceanic medium became more urgent. The shallower waters of the earth's littoral regions are characterized by extreme variability in time as well as space. This project focused on the development of a family of acoustic models that will predict the performance of existing and future Navy sonar systems. Initial efforts concentrated on the development of a multi-source, multi-receiver, fully bistatic ASW system performance prediction capability in support of low-frequency active (LFA) ASW systems (i.e., LFA-Surveillance Towed Array Sonar System or LFA-SURTASS). Further efforts were directed toward the prediction of the performance of mid- and high-frequency tactical and mine warfare sonars, with an eventual goal of high-fidelity simulation.

The following project gains were made during FY92: a multi-source, multi-receiver LFA modeling capability was developed; the Baseline Model components (transmission loss, reverberation, etc.) and detection output results were evaluated against actual sea test data and other scientific algorithms; the AUAMP Baseline 2.6 model was delivered to the Oceanographic and Atmospheric Master Library/Software Review Board (OAML/SRB) as the Navy standard range-dependent LFA performance prediction model; and a volume scattering strength database was delivered to OAML for approval and inclusion in the Navy Standard Master Library.

During FY93, the multi-static Active Sensor Performance Model (ASPM) was updated with more accurate representations of surface loss, and it was used in situation reverberation and noise for real-time predictions and data basing; ASPM at-sea was evaluated during fleet exercises; and efforts were begun to speed up the software code to allow the operator to line up his sensor suite in reasonable time as the environment changes. The ASPM was used to predict the performance of LFA-SURTASS and Extended Echo Range sonobuoy; to modify existing models for mid-frequency sonar design, development, and operational performance prediction to upgrade the current Navy standard; to upgrade the Navy standard ambient noise prediction model to include coast shipping database and new merchant ship source level data; to investigate wind source level; and to complete a Bottom Activated Sensor System model for designing deployable bottom-mounted systems for active and passive use in shallow water and slope environments.

The Phase I LFA-SURTASS Optimization algorithms for sensor suite line-up guidance were developed and tested in FY94. Several tests were conducted, including Critical Sea Tests, Low Frequency Active Sea Tests, and Magellan Exercises.

During FY95, Phase II LFA-SURTASS optimization algorithms for sensor suite line-up guidance were completed and tested; a range-dependent active sonar model was developed for surface ship active sonars in a multi-static setting that will operate in frequencies of 100-3,000 Hz and include multi-sources, multi-receivers, and a bottom loss database continuous over this frequency range for active and passive performance; the high-frequency model was upgraded to include new absorption and target strength algorithms; the HFBL techniques were upgraded with a database for shallow waters of the western Pacific Ocean; and sources of coastal noise were explored and the ambient noise prediction mode upgraded to cover frequencies greater than 500 Hz.

The development of bottom scattering models for minehunting sonars was started in FY96 and incorporated into a high-frequency system performance model. The range-dependent active sonar performance model was verified and validated against data acquired in support of Extended Echo Range sonobuoy and surface ship sonars. When all this was completed, verification and validation of the high-frequency acoustic time series simulator portion of the virtual acoustic ocean were begun.

Other efforts included the completion of phase one of HFBL databases for shallow waters and development of algorithms for addressing bottom reverberation using advanced algorithm and data processing techniques. An improved bottom scattering model that included basement scattering was also developed. A study was conducted of the effect of time spread in thick sediments on the performance of mid-frequency active systems and techniques in processing shallow water reverberation data. This information will be applied to the development of a model to account for clutter in systems performance prediction.

The agenda for FY97 called for completing the upgrade of the Navy Standard Low Frequency Bottom Loss model/database to 5 kHz and completing the interim shallow water clutter prediction models. The Acoustic Sonar Propagation model was transitioned to the Oceanographic and Atmospheric Master Library as a Navy Standard model/database. A broadband propagation model for Fleet use was developed, and a shallow water geo-acoustic inversion technique that makes use of time-spread functions was developed.

In FY98, the development of the clutter prediction model was completed, and an operational sensitivity model was developed to predict the sensitivity of system performance to environmental factors.

Plans for FY98 also called for extending Low Frequency Bottom Loss from the 50 meter contour water depth to very shallow water. In FY99, this effort was transitioned to the Air/Ocean Tactical Applications program.

Project V/X0823 Sensor Performance Prediction (SPP). The SPP Project developed onboard software capabilities that provide sensor performance predictions and Tactical Decision Aids (TDAs) for all tactical platforms, using in-situ measurements, synoptic data and new or updated environmental databases. SPP enhances the full performance potential of complex systems by increasing their detection/tracking performance. The program began to address non-acoustic systems and selected non-ASW platforms in FY92. During FY93, the program began to focus on shallow water/regional conflict scenarios. The project title change in FY94 from Acoustic to Sensor Performance Prediction reflects this broader focus.

By the end of FY93, the project had, among other efforts, developed mine warfare Tactical Decision Aids; updated the Submarine Fleet Mission Program Library (SFMPL) to provide expanded automatic data entry; completed the development and initial at-sea evaluations of SFMPL; completed the integration into the Navy Tactical Command System-Afloat; and upgraded the Surface SPP Advanced Development Model to include measured noise/reverberation data.

The ASWTDA was updated in FY94 to include active search fusion, expanded measured/synoptic environmental data, and non-acoustic detection/counter-detection capabilities, as well as to address the total SPP Expeditionary Decision Support requirements for the littoral regions. The Surface Ship SPP advanced development model (ADM) was updated as well, to include SQS-53C module enhancements and littoral warfare product requirements with at-sea evaluations. Likewise, the Submarine SPP ADM was updated to address sensor/weapon upgrades, increase the use of measured/synoptic environmental data, and incorporate non-acoustic system predictions and non-acoustic vulnerability. The Integrated Carrier ASW Prediction System II and the P-3 Maritime Patrol Aircraft Laptop Prediction System (LAPS) were both upgraded to include Extended Echo Ranging prediction capability, new sonobuoy predictions, processor mode selection guidance, and non-acoustic predictions.

The initial SPP Expeditionary Decision Support Capability program was completed in FY95. Additional efforts focused on: expanding the Surface Ship SPP ADM to include upgraded mine detection/avoidance aids and non-acoustic Tactical Decision Aids; upgrading the Integrated Carrier ASW Prediction System and LAPS to include new sonobuoy prediction capabilities, multi-aircraft multi-sortie search planning, the improved electronic warfare/magnetic anomaly detection module, and improved mine warfare aids; and, finally, expanding the Submarine SPP ADM to include predictions/line-up support, mine warfare decisions aids, all sensor search fusion, and improved weapon preset predictions and expeditionary warfare products. Project plans for the immediate future call for development of a Joint Littoral/Multi-Mission TDA for submarine, air and surface ships. This system will be tied into the Joint Maritime Command Information Systems.

During FY96, the Electro-Magnetic/Electro-Optic Performance Prediction/Decision Support System for anti-submarine, anti-missile, and Air Defense/Strike Warfare was in the initial stages of development. The prototype Electro-Magnetic and Electro-Optic capabilities were incorporated into the current surface ship, air and submarine performance prediction systems' ADM to maximize expeditionary warfare decision support in the littoral areas.

Development of the Joint Littoral/Multi-Mission TDA, for use in shallow water against diesel submarines and low-flying missiles, was expected to be completed by the end of FY97, and then incorporated into an Expeditionary Decision Support System and evaluated during at-sea Fleet Regional Conflict/Littoral exercises.

Numerous efforts were conducted during FY98, many a continuation of projects begun in prior years. Among them, new sensor suites were explored for incorporation on the New Attack Submarine (NSSN), SQQ-89 Block III ships and for LAMPS helicopter upgrades (SH-60R); and sensor performance prediction and employment TDAs were developed that address new generation undersea warfare systems.

Finally, during FY98, atmospheric and oceanographic data acquisition and applications capabilities were under development. These efforts are being conducted to utilize environmental parameters in real-time and distribute them to other Fleet combatants and shore sites.

Plans for FY99 called for incorporating prototype mine warfare tactical decision aids in baseline surface ship, air and submarine performance prediction systems, and ensuring the interoperability of systems via existing Fleet communication mechanisms. The development of prediction capabilities for acoustic and non-acoustic sensors for Fleet combatants was expected to be completed and at-sea evaluations conducted.

Funding

As of FY99, the CSOPA program was consolidated, merged, and transferred to other programs, many of them on the classified level. Funding for this specific effort has been absorbed by other programs and is not specifically itemized.

Recent Contracts

While some R&D contracts have been awarded, the specifics of these contracts are typically classified and not publicly available. However, where it has been possible to identify likely contracts associated with CSOPA, we have listed them below:

Contractor	Award ($ millions)	Date/Description
Analysis & Technology	12.8	Jan 1995 – Indefinite delivery/indefinite quantity, CPFF contract for engineering services in the form of technical analysis and review of warfare system operational performance in support of attack submarine and ballistic missile submarine platforms and warfare systems. (N66604-95-D-0463)
Analysis & Technology	8.1	Jan 1995 – Indefinite delivery/indefinite quantity contract with a CPFF pricing arrangement for simulation development support services for acoustic trainers (sonar). Contract completed by Jan 2000. (N66604-95-D-0041)
Sonalysts	6.3	Mar 1995 – Indefinite delivery/indefinite quantity CPFF contract for scientific, engineering, analytical, and technical services for the development phases of sonar transmitters, receivers and associated equipment in support of the Naval Undersea Warfare Center ASW Department. Contract completed by Mar 2000. (N66604-95-D-0174)
Analysis & Technology	14	Jun 1995 – Indefinite quantity/indefinite delivery CPFF contract for engineering support services for current and future submarines, surface combatants, and advanced naval vehicles. Contract completed by Jun 2000. (N00167-95-D-0081)
Fleet Support Center	12.1	Apr 1995 – CPFF indefinite delivery/indefinite quantity contract to analyze surface ship ASW systems. Contract completed by Apr 2000. (N66604-95-D-0001)
Analysis & Technology	8.8	Jul 1995 – Indefinite delivery/indefinite quantity, CPFF provisions contract for broad development, test and evaluation, fleet integration, and life-cycle support of ASW weapon systems. Contract completed by Jul 2000. (N66604-95-D-A026)
Dynamic Systems	9.0	Aug 1995 – Indefinite delivery/indefinite quantity contract with CPFF provisions for assurance services during all life-cycle phases of underwater ASW combat and weapon systems, and various electronic, electromagnetic and mechanical equipment. Contract completed by Aug 2000. (N66604-94-D-0009)
APL/University of Washington	78	Sep 1996 – CPFF, LOF indefinite delivery/indefinite quantity contract for essential scientific and engineering support in the areas of ocean science, environmental description and effects prediction, torpedoes, mines, navigation, acoustic reconnaissance and search personnel and training, undersea countermeasures, major development and operation, and special sensors. Contract is expected to be completed by September 2001. (N00039-96-D-0061)

Contractor	Award ($ millions)	Date/Description
APL/University of Washington	14.5	Nov 1996 – CPFF, LOF, indefinite delivery/indefinite quantity contract with a maximum LOF of 170,029 hours to provide essential scientific and engineering support in the areas of ocean science, environmental description and effects prediction, torpedoes, mines, navigation, acoustic reconnaissance and search, personnel training, undersea countermeasures, major development and operation, and special sensors. Contract is expected to be completed by Sep 2001. (N00039-96-D-0061)
APL/Pennsylvania State University	322	Dec 1996 – CPFF, LOF task order contract with a maximum LOF of 3.4 million staff hours for research and development in the areas of environmental description and effects prediction, torpedoes, undersea countermeasures, navigation, acoustic reconnaissance and search, mine countermeasures, and special sensors. Contract is expected to be completed by Sep 2001. (N00039-97-D-0042)
Analysis & Technology	11.3	Jun 1997 – An indefinite delivery/indefinite quantity contract with CPFF provisions to provide technical and analytical services during test and evaluation. This includes planning, designing, developing, and collecting data during land-based and at-sea tests of sonar systems, ASW combat systems, and 21st century programs. Contract is expected to be completed by Jun 2002. (Contract number not available at this time)
Analysis & Technology	21.1	Mar 1998 – CPFF indefinite delivery/indefinite quantity completion contract to provide research and development services in support of projects and programs involving acoustic simulation and tactics. The primary focus of this research program is the conduct of numerical analyses of ocean acoustics and those aspects of the environment relevant to acoustic propagation, environmental acoustic analysis, and littoral/expeditionary warfare systems support. Contract is expected to be completed by Mar 2003. (N0017-98-C-6008)

Timetable

Year	Major Development
1966	LRAP established for SOSUS
1977	Shore-based VLAD sonobuoy developed
FY79	Shallow water acoustic program initiated
FY80	LAMBDA system deployed
FY83	Acoustic Range Prediction Systems installed at Fleet Numerical
FY84	Acoustic data for surveillance system performance analyzed
FY84	Mine and mine countermeasure shallow-water data analyzed
FY85	Delivery of prototype prediction system for mines/mine countermeasures; new Acoustic System Range Prediction System at FNOC installed
FY86	Testing of prototype on-scene acoustic performance prediction system for mines and mine countermeasures completed. Acoustic databases moved to FNOC
FY87	SPARS model prepared for transition to Space and Naval Warfare Systems Command to support surveillance efforts
FY88	SPARS model moved to Space and Naval Warfare Systems Command
FY89	Range-dependent prediction models delivered
FY95	Expanded program to reflect changes in threat environment; emphasis on limited conflict, shallow water ASW and MCM environmental conditions
FY96	Joint Littoral/Multi-Mission Decision Aid Critical Design Review
FY97	Joint Littoral/Multi-Mission Decision Aid sea test
FY98	Complete development of clutter prediction model

Year	Major Development
FY99	Projects transferred to other programs where they will be merged with existing projects

Worldwide Distribution

This program was exclusive to the **US Navy**.

Forecast Rationale

Several years ago, the US Department of Defense turned its focus from the global threat of the now-defunct Soviet Union to the future regional conflict scenarios outlined in the Defense Planning Guide. Most of the scenarios in the Guide require operation of naval forces in the Earth's littoral waters, which are shallow and have highly variable (in space and time) oceanographic conditions and confined maneuvering space. Of major concern to the US Navy has been the dual threat posed by very quiet diesel submarines capable of opposing US naval forces and sea mines. These submarines could dramatically restrict force mobility and hamper or curtail amphibious operations.

In order to combat such threats, there was an urgent need for the Navy to fully understand the ocean areas in which they likely would operate in the future. The Combat Systems Oceanographic Performance Assessment (CSOPA) provided the necessary research and development to do the following: rapidly and automatically acquire a broad array of oceanic data to optimize system performance; accurately predict the performance of warfighting systems under development or employed in those areas; develop or modify existing environmental acoustic models and databases to support assessments of regional conflict ocean areas; develop environmentally sensitive decision aids to support tactical decisions made in real-time during a regional conflict; and develop a synthetic environment module (virtual ocean), which will drive future simulations.

The US Navy's Combat Systems Oceanographic Performance Assessment (CSOPA) program (formerly titled ASW Environmental Acoustic Support [AEAS]) conducted oceanographic/atmospheric research and development (R&D) to acquire greater understanding of the environment and its impact on combat systems performance. Its purpose was to predict and then enhance the performance of current and proposed undersea surveillance, tactical and weapons systems. This effort was accomplished through at-sea experimentation; numerical model and database development; development and evaluation of stand-alone and Command, Control, Communications, Computers, and Intelligence (C^4I) system embedded prediction/tactical decision aid products; Fleet technical support; and instrumentation development. Emphasis was placed on shallow water and other harsh environments, and on regional conflict scenarios.

After the Cold War, an increase in regional conflicts also signaled a need for operations in shallow water and other harsh environments. The research and assessments under Combat Systems Oceanographic Performance had been predominately aimed at ASW operations against nuclear and diesel-electric submarines. Thanks to the changes in naval strategy, however, the program also included mine detection and countermeasures, torpedo detection and avoidance, and special operations warfare.

Ten-Year Outlook

The CSOPA program has been merged with other programs. The forecast chart has been omitted. This report will be archived next year, 2001.

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