FY 2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: Feb 2004
Exhibit R-2

BA: 02 PROGRAM ELEMENT: 0602435N
PROGRAM ELEMENT TITLE: Ocean Warfighting Environment Applied Research

COST: (Dollars in Thousands)

Project Number & Title	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
Ocean Warfighting Environment Applied Research	66,431	62,305	48,482	56,525	55,031	51,464	52,445

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program provides the unique, fundamental programmatic instrument by which basic research on the natural environment is transformed into technology developments that provide new or enhanced warfare capabilities for the BattleSpace Environment (BSE). The objectives of this program are met through measuring, analyzing, modeling and simulating, and applying environmental factors affecting Naval material and operations in the BSE. This program provides for BSE technology developments that contribute to meeting top joint warfare capabilities established by the Joint Chiefs of Staff, with primary emphasis on Joint Littoral Warfare and Joint Strike Warfare.

This program fully supports the Director of Defense Research and Engineering's Science and Technology Strategy and is coordinated with other DoD Components through the Defense Science and Technology Reliance process. Work in this program is related to and fully coordinated with efforts in accordance with the ongoing Reliance joint planning process. There is close coordination with the US Air Force and US Army under the Reliance program in the Battlespace Environment categories of Lower Atmosphere, Ocean Environments, Space & Upper Atmosphere, and Terrestrial Environments. Within the Naval Transformation Roadmap, the investment will contribute toward achieving each of the "key transformational capabilities" required by Sea Strike, Sea Shield, and Sea Basing. Moreover, environmental information, environmental models and environmental tactical decision aids that emerge from this investment will form one of the essential components of FORCEnet (which is the architecture for a highly adaptive, human-centric, comprehensive maritime system that operates from seabed to space). The Navy program includes efforts that focus on, or have attributes that enhance, the affordability of warfighting systems.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

FY 2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: Feb 2004
Exhibit R-2

BA: 02 PROGRAM ELEMENT: 0602435N
PROGRAM ELEMENT TITLE: Ocean Warfighting Environment Applied Research

PROGRAM CHANGE SUMMARY:

	FY 2003	FY 2004	FY 2005
FY 2004-2005 President's Budget Submission	71,027	48,785	63,729
Cong. Rescissions/Adjustments/Undist.Reductions	0	-705	0
Congressional Actions	0	14,225	0
Execution Adjustments	-3,509	0	0
Inflation Savings	0	0	-190
Rate Adjustments	0	0	-57
SBIR Assessment	-1,087	0	0
Technical Adjustments	0	0	-15,000
FY 2005 President's Budget Submission	66,431	62,305	48,482

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.
Schedule: Not applicable.

FY 2005 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: Feb 2004

Exhibit R-2a

BA: 02 PROGRAM ELEMENT: 0602435N PROGRAM ELEMENT TITLE: Ocean Warfighting Environment Applied Research

PROJECT TITLE: Ocean Warfighting Environment Applied Research

COST: (Dollars in Thousands)

Project Number & Title	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate
Ocean Warfighting Environment Applied Research	66,431	62,305	48,482	56,525	55,031	51,464	52,445

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project provides technologies that form the natural environment technical base on which all systems development and advanced technology depend. Further, this technical base provides developments that may be utilized in the Future Naval Capabilities (FNC) programs: Organic Mine Countermeasures, and Autonomous Operations. This project contains the National Oceanographic Partnership Program (NOPP) (Title II, subtitle E, of Public Law 104-201).

Major efforts of this project are devoted to (1) gaining real-time knowledge of the Battlespace Environment (BSE), (2) determining the natural environment needs of regional warfare, (3) providing the on-scene commander with the capability to exploit the environment to tactical advantage, and (4) developing atmospheric research related to detection of sea-skimming missiles and strike warfare. This project provides natural environment applied research for all fleet operations and for current or emerging systems. Major developments are routinely transitioned to the Fleet Numerical Meteorology and Oceanography Center and to the Naval Oceanographic Office where they are used to provide timely information about the natural environment for all fleet operations.

Joint Littoral Warfare efforts address issues in undersea, surface, and air battlespace. Efforts include ocean and atmospheric prediction for real-time description of the operational environment, shallow water acoustics and multiple-influence sensors for undersea surveillance and weapon systems, and influences of the natural environment on Mine CounterMeasure (MCM) and Anti-Submarine Warfare (ASW) systems. Joint Strike Warfare efforts address issues in air battlespace dominance. Efforts include influences of the natural environment on air operations, electromagnetic (EM)/electro-optic (EO) systems used in intelligence, surveillance, reconnaissance, targeting, bomb damage assessment, and detection of missile weapon systems. They also include improvements in tactical information management about the BSE.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2003	FY 2004	FY 2005
Battlespace Environment (BSE) Sensors and Data	7,366	6,736	7,797

This activity encompasses efforts to develop new, or enhance existing, shipboard, airborne, and spaceborne sensors and appropriate inversion techniques and data handling techniques to obtain/store/manage environmental data. Data on a variety of processes in the environment are essential for several reasons: the data can serve as input to computer prediction schemes, data can be used to provide characterizations of processes for use in other developments, and data can be used in testing/validating the current understanding of ocean and atmospheric behavior. Consideration is routinely given to the basic research available in Sensors and Data to determine if new opportunities exist that can be exploited to rapidly advance toward the goals of the BSE Sensors and Data activity. Consideration is also routinely given to the nature of the technical efforts to ensure that they represent the most effective means of achieving progress. Efforts include use of organic sensors to characterize the operational environment in real-time for input into performance prediction of warfighting systems. Developments in the BSE Sensors and Data activity are of importance to littoral oceanography, amphibious warfare, mine countermeasures, and anti-submarine warfare. A main emphasis of work in this area remains the littoral ocean which continues to be seen as the primary battlespace of future conflicts. The BSE Sensors and Data activity supports the Navy Transformation Roadmap strategy by providing required data that can be applied to battlespace characterization in near real-time and also employed in intelligence, surveillance, and reconnaissance.

FY 2003 Accomplishments:
- Continued development in: Global Ocean Data Assimilation Experiment (GODAE), bioluminescence sensor, field data for physics-based models for hyperspectral imaging sensors, Naval impact of natural environmental processes (especially for the Littoral Zone (LZ)). Continued developments in Autonomous Underwater Vehicle (AUV) sensors and technology for oceanography, mine countermeasures, and prediction of mine burial.
- Continued North Atlantic Treaty Organization (NATO) Adriatic circulation experiment: field tested a new bottom sensor system, and used data for Rapid Environmental Assessment (REA).

FY 2004 Plans:
- Continue efforts to transition small, low-power, lightweight bioluminescence sensors, which are of importance to Special Operations Forces.
- Continue efforts to use space-based optical sensors as input for both active and passive optical mine countermeasure sensors.
- Continue to perform field data analysis of physics-based models for hyperspectral imaging of the ocean

surface/near-surface to establish what information can be deduced about the ocean's upper layers.
- Continue development of a shipborne Light Detection and Ranging (LIDAR) system for measurement of winds and the near-surface Electromagnetic/Electro-Optic (EM/EO) propagation environment.
- Continue efforts, where feasible, to develop ocean sensors for use on AUVs and the development of acoustic communication capabilities to transfer data to facilities in the field.
- Continue efforts to utilize organic sensors for REA.
- Continue research into ocean wave prediction, especially shoaling waves, based on the extensive basic research measurement programs in this area over the past decade, and advanced techniques such as the Higher Order Spectral Model.

FY 2005 Plans:
- Continue bioluminescence sensor effort with emphasis on needs of the Special Warfare (SPECWAR) forces, survey capabilities, and use of the bioluminescence sensors in joint field measurements with ocean sensors to determine persistence of the bioluminescence signal and the ocean factors controlling the persistence.
- Continue efforts to develop ocean sensors for use on AUVs and to develop acoustic communication capabilities to transfer data to facilities in the field. Utilize joint field work with other AUV technology developers and users as a routine aspect of the program.
- Continue research into ocean wave prediction, especially shoaling waves, based on the extensive basic research measurement programs over the past decade. Ocean waves constitute a key process in the LZ with the ability to affect many Naval operations and we seek as robust a predictive capability as possible.
- Complete analysis of data of the upper ocean structure collected from hyperspectral imaging sensors.
- Conduct a field test of a shipborne LIDAR system for near-surface environmental characterization.

	FY 2003	FY 2004	FY 2005
Battlespace Environment (BSE) Concept Enablers	20,051	19,065	19,091

This activity focuses on concept enablers for the BattleSpace Environment (BSE) which represent technology developments that are expected to provide revolutionary enabling capabilities, but require a long period of development. Consideration is routinely given to the goals of this work to ensure that they are adequate for the presumed Naval warfare needs as reflected in higher level Navy Science and Technology strategy. This particular activity is most sensitive to opportunities as presented by breakthroughs in the basic research domain which may represent new opportunities for achieving goals of the BSE Concept Enablers activity. The ever recurring theme of the BSE Concept Enablers activity is to advance technologies that offer the warfighter the greatest capabilities for gaining "advantage" over the natural environment, both to increase his warfighting ability and to deny an adversary any "home field" advantage. The aims of this activity are fully

consistent with the Navy Transformation Roadmap strategy.

FY 2003 Accomplishments:
- Continued research into geoclutter, as a means of developing better insights into how the sub-sediment seafloor may contribute to acoustic clutter.
- Continued development of methods for capturing uncertainty in environmental prediction estimates with the ultimate goal of ensuring the user of the reliability of these predictions. There is a crucial need for this capability, especially in the littoral zone where so much variability in the environment may occur.
- Continued development and analysis of air-sea interaction measurements and theory. Efforts are expected to have an impact on improved ocean and atmospheric models as well as better understanding of how aerosols are injected into the lower atmosphere where they have a decisive influence on electromagnetic and electro-optic propagation.
- Continued efforts in marine mammal research and noise mitigation, which poses a variety of challenges to Naval operations.
- Continued support of the National Oceanographic Partnership Program (NOPP).
- Continued Support of "Ocean.US" Office, which is a component of NOPP that represents the US component of a global ocean observing system.
- Developed new possibilities in biosensor technology.

FY 2004 Plans:
- Continue developments, through theory and field measurement, in the air-sea interaction research effort, as a means of improving both ocean and atmospheric forecasts.
- Continue marine mammal noise mitigation efforts to develop tools to detect and mitigate effects of noise on marine mammals, especially the noise generated by Naval activities.
- Continue the following NOPP efforts begun in earlier years: Real-Time Forecasting System of Winds, Waves, and Surge in Tropical Cyclones; The Partnership for Advancing Interdisciplinary Global Modeling (PARADIGM), a Partnership for Modeling the Marine Environment of Puget Sound, Washington, Ocean Data Assimilation Experiment (GODAE), and Multi-Disciplinary Ocean Sensors for Environmental Analyses and Networks.
- Continue development of new possibilities in biosensor technology.
- Complete effort in capturing uncertainty in environmental predictions as a means of giving the user an idea of the reliability of those predictions.
- Complete geoclutter effort to elucidate how the sub-sediment seafloor contributes to acoustic clutter and the importance of this environmental effect in anti-submarine warfare. Determine how variability of the sub-sediment seafloor may contribute to false targets and whether a means can be developed to reduce such false targets.
- Complete the following NOPP efforts: Development and Verification of a Comprehensive Community Model for

Physical Processes in the Nearshore Ocean, Hybrid Coordinate Ocean Model (HYCOM).

FY 2005 Plans:
- Continue marine mammal program on noise mitigation.
- Continue to support efforts in GODAE as a contribution to data assimilation for global ocean prediction capability through collaboration between the Navy's Fleet Numerical Meteorological and Oceanography Center and the NOAA Pacific Marine Environmental Laboratory, as well as others.
- Continue to solicit efforts from the national oceanographic community that will advance the NOPP program towards its goal of an integrated ocean observing and prediction system.
- Continue development of new possibilities in biosensor technology.
- Complete the following NOPP efforts: A Consortium for Data Assimilative Ocean Modeling, a Consortium for Ocean Circulation and Climate Estimation. Continue NOPP efforts begun in earlier years.

	FY 2003	FY 2004	FY 2005
Ocean and Atmospheric Modeling/Prediction and Effects	11,745	10,585	10,985

The battlespace environment represents a critical factor in Naval warfare and in any Naval operation, often resulting in a "go" or "no-go" decision for any contemplated action. The extent to which this environment can be modeled, through computational models used in making predictions of characteristics of the environment, provides an important means by which Naval forces can gain mastery over the environment and deny an adversary "home field" advantage. Consideration is routinely given to the nature of developments in Ocean and Atmospheric Modeling/Prediction and Effects to ensure that the technical efforts take appropriate account of developments in basic research and represent the most effective means of achieving progress toward the goals of the Ocean and Atmospheric Modeling/Prediction activity. Consideration is also routinely given to basic research developments in this active technology area that are ready for incorporation into this applied research program. This activity will enable Naval forces to have unprecedented knowledge of the battlespace and its environmental conditions, which is fully consistent with the SEA POWER 21 strategy.

FY 2003 Accomplishments:
- Continued development of ocean model nowcast/forecast at a variety of scales (global, regional, semi-enclosed seas, local) including relocateable and nested models.
- Continued development of advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander.
- Continued model testing and validation. Transitioned the Navy Coastal Ocean Model (NCOM) for operational test/evaluation at the Naval Oceanographic Office (NAVO), and initiated an effort to incorporate an upgraded Polar Ice Prediction System (PIPS3) into NCOM to extend its applicability.
- Conducted research on the atmospheric effects on electromagnetics and electro-optics. This is important because electromagnetic and electro-optic propagation affects many modern warfare systems.
- Continued construction of an end-to-end observation/analysis/prediction system for coastal aerosol and dust which continues to be an important focus of activities in atmospheric effects as demonstrated in the Persian Gulf conflict and, most recently, in Operation Enduring Freedom.
- Continued transition to NAVO and Navy SEAL forces the laptop-based nearshore forecast system that makes use of Autonomous Underwater Vehicle (AUV) collected data.

FY 2004 Plans:
- Continue developments in ocean model nowcast/forecast at a variety of scales (global, regional, semi-enclosed seas, local) including relocateable and nested models.
- Continue to employ ocean models to complete 3-D acoustic simulations of space-time coherence of the acoustic field, which is a primary characteristic related to detection performance of acoustic systems.
- Continue efforts in nested models to allow for a larger domain ocean model to set boundary conditions for a smaller domain model. Incorporate high-resolution regional nests into the NCOM.
- Continue development in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander.
- Pursue further developments in atmospheric effects on electromagnetics and electro-optics. Develop methods for determination of refractivity from clutter as an inverse method of obtaining the critical refractivity properties of the atmosphere that affect electromagnetic/electro-optic propagation.
- Construct an end-to-end observation/analysis/prediction system for coastal aerosol and dust.
- Complete transition to NAVO and Navy SEAL forces the laptop-based nearshore forecast system that makes use of Autonomous Underwater Vehicle (AUV) collected data.

FY 2005 Plans:
- Advance efforts in ocean model nowcast/forecast at a variety of scales (global, regional, semi-enclosed seas, local) including relocateable and nested models dependent on other priorities in this area.
- Continue developments in nested models dependent on other priorities in this area to allow for a larger

domain ocean model to set boundary conditions for a smaller domain model.
- Continue development in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander.
- Continue developments in atmospheric effects on electromagnetics and electro-optics because of the central importance of electromagnetic and electro-optic propagation to so many modern warfare systems.
-Continue to develop methods for determination of refractivity from clutter as an inverse method of obtaining the critical refractivity properties of the atmosphere that affect electromagnetic/electro-optic propagation.
- Complete first tests of coupled global and regional aerosol prediction system. Efforts aim to build on recent successes of the application of atmospheric modeling demonstrated in Operation Enduring Freedom.

	FY 2003	FY 2004	FY 2005
Naval Warfare System-Focused Efforts	10,608	9,380	10,609

This program element is the only applied research program element dedicated to determination of the impact of the natural environment on Naval warfare and Naval operations. As such, many questions about the impact of the natural environment on either operational systems or on Naval warfare systems under development and their performance become technical issues for this program element. The Littoral Zone (LZ) has been the natural environment of greatest interest. Aspects of this environment that greatly impact Naval warfare are the generally shallow waters of the LZ, the consequent closeness and physical significance of the ocean bottom, and the complexities inherent to potentially rapid changes of the ocean structure as well as the ocean bottom. Continual evaluation is given to the state of Naval warfare systems to ensure that technology development in the Naval Warfare System-Focused Efforts activity reflects the optimum choices for greatest impact of the work on Naval systems. This activity, through its focus on impact of the natural environment on Naval warfare systems, supports the Navy Transformation Roadmap strategy by exploiting knowledge of the environment to gain advantage over potential adversaries.

FY 2003 Accomplishments:
- Measured and modeled ship wake acoustics for anti-torpedo torpedo acoustic performance prediction.
- Incorporated improved shock physics and numerics into an explosive mine neutralization model.
- Developed remote sensing techniques, especially hyperspectral imaging technology, for the LZ because of their very promising potential to allow inference of littoral ocean characteristics and overcome the problem of "denied" waters.
- Developed several aspects of underwater acoustics because of their general importance to acoustic systems: validated models of horizontal acoustic coherence through oceanographic reconstructions for environmental impact on acoustics, modified the primitive equation solution model for the Yellow Sea and transitioned the capability for solution internal wave packet predictions, and determined acoustic focusing and the

predictability of acoustic energy fluctuations due to the internal wave/coastal front influences on acoustic propagation.
- Continue developments in environmentally-sensitive, physics-based decision tools and measures of effectiveness in predictive systems as a means for providing the fleet useful environmental tactical decision aids for antisubmarine warfare as well as mine warfare.

FY 2004 Plans:
- Continue developments in the area of utilization of acoustic processing techniques to perform acoustic or geoacoustic inversion for environmental parameters, develop techniques for discrimination between environmental scatterers and target, and through-the-sensor measurements and adaptation of sensors to the environment.
- Continue development in remote sensing techniques, which include passive/active optical, electromagnetic, and acoustic techniques.
- Pursue techniques to allow determination of sediment microfabric and geotechnical properties and their exploitation in Naval warfare, especially where related to mine burial and prediction.
- Continue developments in the area of underwater acoustics and the impact of ocean dynamics on underwater acoustics because of their general importance to acoustic systems.
- Continue developments in environmentally-sensitive, physics-based decision tools and measures of effectiveness in predictive systems as a means for providing the fleet useful environmental tactical decision aids for antisubmarine warfare as well as mine warfare.
- Continue to measure/model ship wake acoustics for anti-torpedo torpedo acoustic performance prediction.
- Continue improvements in shock physics and numerics for an explosive mine neutralization model.

FY 2005 Plans:
- Continue developments in the area of utilization of acoustic processing techniques.
- Continue development in remote sensing techniques, especially the hyperspectral techniques in the LZ which offer new possibilities for exploitation based on previous investigation.
- Continue development of techniques to allow determination of sediment geoacoustic and geotechnical properties and their exploitation in Naval warfare.
- Continue developments in the area of underwater acoustics and the impact of ocean dynamics on underwater acoustics on a very selective basis. Important objectives are the integration of environmental knowledge into acoustic signal processing, underwater noise prediction and characterization, and noise models.
- Continue developments to account for the environmental impact of ocean processes on acoustics and improvements in noise models as a new means for detection of submarines in acoustic recordings.
- Continue developments in environmentally sensitive, physics-based decision tools, and measures of effectiveness in predictive systems.

- Make initial estimates, based on previous year's measurements, of acoustic performance prediction of the anti-torpedo torpedo.
- Optimize explosive placement pattern for air-dropped mine countermeasures weapon systems using improved sediment shock physics models.

CONGRESSIONAL PLUS-UPS:

	FY 2003	FY 2004
BIOLUMINESCENCE TRUTH DATA AND SIGNATURE DETECTION	954	989

Advances in basic research over several years on bioluminescence in the ocean have enabled the development of a fundamental understanding of the phenomena and the Navy operations that may be affected. This effort funds research into the development of affordable, compact, efficient sensors that will allow ease of deployment and permit the rapid measurement of bioluminescence in the world's oceans in order to create a database for future research.

	FY 2003	FY 2004
CENTER FOR MARITIME SYSTEMS	0	2,769

The Center for Maritime Systems (CMS) is focusing on two key areas in the emerging needs for the design of small vessels capable of operating in coastal regions in a wide range of weather and ocean conditions: establishing an environment where engineering disciplines associated with hull design and ship automation can be brought together, and utilizing this unique education and research environment to identify new areas for research and invent new tools to meet the Navy's needs.

	FY 2003	FY 2004
EXTENDED CAPABILITY UNDERWATER IMAGING	1,910	2,225

This effort supports research into the development of smaller, more energy efficient sensors for autonomous underwater vehicles with an enhanced ability to detect and identify man-made objects in support of mine and undersea warfare.

	FY 2003	FY 2004
HYDROGRAPHY RESEARCH	1,671	0

This effort funded initial experimentation into tools to provide the Warfighter with high-resolution hydrographic data in near-coastal denied regions.

	FY 2003	FY 2004
OCEANOGRAPHIC SENSORS FOR MCM	4,871	4,623

This effort funds research into the development of small, low-power sensors to use on small autonomous underwater vehicles designed for covert characterization of denied areas, thereby giving the Navy a new capability in mine countermeasure operations.

	FY 2003	FY 2004
SOUTH FLORIDA OCEAN MEASUREMENT CENTER	954	0

Supported the South Florida Ocean Measurement Center, which is a consortium of universities and agencies with oceanographic expertise centered in South Florida and has an extensive range of oceanographic capabilities and facilities.

	FY 2003	FY 2004
SOUTHEAST ATLANTIC COASTAL OCEAN OBSERVING SYSTEM (SEACOOS)	5,349	5,933

SEACOOS represents a regional partnership that will initiate an integrated coastal ocean observing system for a four-state region of southeast coastal U.S. (NC, SC, GA, FL). Widespread access of data will significantly improve our understanding of atmospheric, oceanic and coupled behaviors in the southeastern U.S., Bahamas, northern Caribbean basin and in the surrounding larger-scale systems. This effort has importance for Homeland Security as well as for Naval oceanography in general.

	FY 2003	FY 2004
SOUTHERN COASTAL OCEAN OBSERVATION PROGRAM (SCOOP)	952	0

Supported the Southern Coastal Ocean Observation Program (SCOOP) which improves oceanographic knowledge, data, tools, and other products emerging from an appropriate infrastructure that would support numerous future Naval operations and enable the Navy to increase its participation in the on-going National Oceanographic Partnership Program (NOPP).

C. OTHER PROGRAM FUNDING SUMMARY:

NAVY RELATED RDT&E:
- PE 0601153N (Defense Research Sciences)
- PE 0602114N (Power Projection Applied Research)
- PE 0602123N (Force Protection Applied Research)
- PE 0602235N (Common Picture Applied Research)
- PE 0602271N (RF Systems Applied Research)
- PE 0602747N (Undersea Warfare Applied Research)
- PE 0602782N (Mine and Expeditionary Warfare Applied Research)
- PE 0603207N (Air/Ocean Tactical Applications)
- PE 0603271N (RF Systems Advanced Technology)
- PE 0603747N (Undersea Warfare Advanced Technology)
- PE 0603782N (Mine & Expeditionary Warfare Advanced Technology)
- PE 0604218N (Air/Ocean Equipment Engineering)

NON-NAVY RELATED RDT&E:
- PE 0602601F (Space Technology)
- PE 0602784A (Military Engineering Technology)
- PE 0603401F (Advanced Spacecraft Technology)

D. ACQUISITION STRATEGY: Not Applicable.