FY 2007 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: Feb 2006
Exhibit R-2

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602435N
PROGRAM ELEMENT TITLE: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2005 Actual	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	69,447	62,470	48,718	50,243	50,809	51,407	52,011

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program element (PE) provides the unique, fundamental programmatic instrument by which basic research on the natural environment is transformed into technological 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 technological 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 PE 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 on-going Reliance joint planning process. There is close coordination with the US Air Force and US Army under the Reliance program in the BSE 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.

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B. PROGRAM CHANGE SUMMARY:

	FY 2005	FY 2006	FY 2007
FY 2006 President's Budget Submission	69,601	49,793	50,353
Congressional Action	0	13,425	0
Congressional Undistributed Reductions/Rescissions	-53	-748	0
Execution Adjustments	866	0	0
FY 2005 SBIR	-967	0	0
Program Realignment	0	0	-1,504
Rate Adjustments	0	0	-131
FY 2007 President's Budget Submission	69,447	62,470	48,718

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
All Science and Technology model improvements undergo a rigorous validation, verification and evaluation against quantifiable metrics before being accepted for transition into operations. In Marine Meteorology, for example, typical improvements over the past decade have amounted to a gain in skill of one forecast-day (i.e., the 4-day forecast is now as skillful as the 3-day forecast of a decade ago), and tropical cyclone forecast track error has been reduced by 50%. It is expected that future increases in skill will continue at or above this pace.

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COST: (Dollars in Thousands)

Project Number & Title	FY 2005 Actual	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	48,426	49,045	48,718	50,243	50,809	51,407	52,011

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. Furthermore, this technical base provides developments that may be utilized in the Future Naval Capabilities programs: Organic Mine Countermeasures (MCM) and Autonomous Operations. This project contains the National Oceanographic Partnership Program (NOPP) (Title II, subtitle E, of Public Law 104-201) and efforts aimed at understanding and predicting the impacts of underwater sound on marine mammals.

Major efforts of this project are devoted to: gaining real-time knowledge of the Battlespace Environment (BSE), determining the natural environment needs of regional warfare, providing the on-scene commander with the capability to exploit the environment to tactical advantage and, 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 analysis and prediction for real-time description of the operational environment, shallow water acoustics, multiple-influence sensors for undersea surveillance and weapon systems, and influences of the natural environment on 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.

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B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2005	FY 2006	FY 2007
BATTLESPACE ENVIRONMENT (BSE) CONCEPT ENABLERS	18,636	0	0

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 (S&T) 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.

The transition to a revised activities structure in this PE resulted in a 100% decrease in FY 2006 and FY 2007. FY 2006 and out BSE activities are reflected elsewhere within this PE.

FY 2005 Accomplishments:

- Continued engineered microbial synthesis and processing of energetic materials (Moved into PE 0602435N in FY 2005. Will be moved to PE 0602236N in FY 2006 because of realignment of activities in PE 0602435N and PE 0602123N).
- Continued development of reagentless sensors for weapons of mass destruction/explosives, including luminescent quantum dot-based biosensors and engineered protein based sensors for detection of toxins (e.g., ricin, domoic acid) and explosives (e.g., TNT, RDX). (Will be moved to PE 0602123N in FY 2006 because of realignment of activities).
- Completed development of a new global atmospheric ensemble prediction system for capturing uncertainty in environmental predictions. (NRL)
- Completed the field measurements and analysis of the air-sea interaction research effort with the goal of improving both ocean and atmospheric forecasts. (NRL)

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The following efforts transition to new activity National Oceanographic Partenrship Program (NOPP) in FY 2006:
- Continued marine mammal program on noise mitigation.
- Continued 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; Global Ocean Data Assimilation Experiment (GODAE); Multi-Disciplinary Ocean Sensors for Environmental Analyses and Networks (MOSEAN); and Hybrid Coordinate Ocean Model (HYCOM).

The following efforts transition to new activity Coastal Geosciences/Optics/Biology in FY 2006:
- Continued algorithm developments for novel navigation and communications among multiple Unmanned Undersea Vehicles (UUVs). (NRL)
- Continued development of gravity-based navigation and a prototype accelerometer/gravimeter system for submarines. (NRL)
- Continued work on Advanced Techniques for Net-Centric Warfare to create a Naval Advanced Meteorology and Oceanography (METOC) Broker to reliably find and broker data from new and ad-hoc METOC data providers to the warfighter in an automated manner. (NRL)
- Continued development of a Benthic Unattended Generator to power an autonomous ocean environmental profiler and provide demonstration. (NRL)
- Initiated programs in detection of fish by acoustic methods. (NRL)

FY 2006 Plans:

- Program transitions to new activities as noted in FY 2005 accomplishments.

FY 2007 Plans:

- Program transitions to new activities as noted in FY 2005 accomplishments.

	FY 2005	FY 2006	FY 2007
BATTLESPACE ENVIRONMENT (BSE) SENSORS AND DATA	7,701	0	0

This activity encompasses efforts to develop new, or enhance existing, shipboard, airborne, and spaceborne sensors. Also, appropriate inversion techniques and data handling techniques to obtain, store, and manage environmental data. Data on a variety of processes in the environment are essential for several reasons: the

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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 Battlespace Environment (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 (MCM), 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 employed in intelligence, surveillance, and reconnaissance.

The transition to a revised activities structure in this PE resulted in a 100% decrease in FY 2006 and FY 2007. FY 2006 and out BSE activities are reflected elsewhere within this PE.

FY 2005 Accomplishments:

The following efforts transition to new activity Coastal Geosciences/Optics/Biology in FY 2006:
- Continued development of optical property retrieval techniques to generate sharper images from optical sensors that are often blurred by the environment. (NRL)
- Continued bioluminescence sensor effort with emphasis on needs of the Special Warfare (SPECWAR) forces and Naval Oceanographic Office, 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.
- Continued efforts to use space-based optical sensors as input for both active and passive optical MCM sensor performance prediction models.
- Continued 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 optical properties of the ocean’s upper layers.
- Continued model development for diver visibility prediction in support of Explosive Ordnace Disposal (EOD) and SPECWAR operations.
- Continued development of sensors to characterize diver visibility in support of EOD and SPECWAR operations.

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- Continued field test of a shipborne Light Detection and Ranging (LIDAR) system for near surface environmental characterization. (NRL)
- Continued to extend studies of ionospheric scintillation phenomena using satellite-satellite measurements providing near global coverage using the Scintillation and Tomography Receiver in Space (CITRIS) instrument to the Space Test Program Satellite (STPSAT1) mission. (NRL)
- Continued development of innovative naval biosensors, biomaterials, and bioprocess technology.
- Continued to refine algorithms that fuse sediment information extracted from operational sonars with historical sediment databases. (NRL)
- Continued to identify and model the dominant sources of coastal undersea environmental electric and magnetic noise and develop methods to mitigate their affects on multiple sensor detection performance. (NRL)
- Continued a technique using hyperspectral and motion imagery in the Littoral Zone (LZ) which offer new possibilities for exploitation based on previous investigation. (NRL)
- Continued development of adaptive algorithms for image enhancement using an operational MCM electro-optic system and provide a demonstration. (NRL)
- Completed demonstration of littoral environmental nowcasting using airborne electro-optical motion imagery and advanced oceanographic models (NRL).
- Completed modification of NRL algorithm, which clusters features in sidescan imagery to perform 2D clustering (by geospatial X,Y location) of features on electronic charts and determined clutter density (NRL).
- Completed participation in joint field work with other Autonomous Undersea Vehicle (AUV) technology developers and users to test undersea sensors. (NRL)
- Initiated programs for promising new biological and chemical sensors.

The following effort transitions to new activity Physical Oceanography in FY06:
- Continued to develop improved ocean wave prediction, especially shoaling waves, based on the extensive basic research measurement programs in this area over the past decade. (NRL)

FY 2006 Plans:

- Program transitions to new activities as noted in FY 2005 accomplishments.

FY 2007 Plans:

- Program transitions to new activities as noted in FY 2005 accomplishments.

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	FY 2005	FY 2006	FY 2007
OCEAN AND ATMOSPHERIC MODELING/PREDICTION AND EFFECTS	11,734	0	0

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.

The transition to a revised activities structure in this PE resulted in a 100% decrease in FY 2006 and FY 2007. FY 2006 and out activities are reflected elsewhere within this PE.

FY 2005 Accomplishments:

- Completed first tests of coupled global and regional aerosol prediction system with data assimilation. Efforts aimed to build on recent successes of the application of atmospheric modeling demonstrated in Operation Enduring Freedom.
- Completed techniques to provide scalable 3-D acoustic propagation model into Navy Oceangraphic and Atmospheric Master Library (OAML). (NRL)

The following projects transition to new activity Marine Meteorology in FY 2006:
- Continued developments in atmospheric effects on electromagnetics and electro-optics because of the central importance of electromagnetic and electro-optic propagation to many modern warfare systems. (NRL)
- Continued 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.

The following projects transition to new activity Physical Oceanography in FY 2006:

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- Continued the study of the effect of shoaling waves on ocean wave prediction. (NRL)
- Continued the development of techniques, software, and testing of a global relocation capability for ocean circulation models with a focus on the littoral ocean. (NRL)
- Continued developments of efforts in atmospheric and ocean model nowcast/forecast systems at a variety of scales (global, regional, semi-enclosed seas, local) including relocateable and nested models dependent on other priorities in this area. (NRL)
- Continued 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.
- Continued development in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander.
- Continued to extend current theory dealing with tidal variations in sound-speed to sound-speed events with strong range dependence. (NRL)
- Continued study of coastally buoyant jets using a combination of observations and numerical models. (NRL)
- Continued efforts in nested models to allow for a larger domain ocean model to set boundary conditions for a smaller domain model. Incorporated high-resolution nests into the Navy Coastal Ocean Model (NCOM). (NRL)
- Continued development of mass conserving baroclinic finite element models using discontinuous Galerkin methods. (NRL)
- Continued studies of the monitoring and evaluation of ocean currents and water mass properties near topographic control points in marginal seas. (NRL)
-Initiated effort in undersea persistent surveillance to provide detailed, real-time oceanographic information for sensing and sensor performance predictions.
- Initiated development of predictive capability of internal wave affects on the battlespace, including affects on acoustic transmission.
- Initiated effort in undersea persistent surveillance to provide detailed, real-time oceanographic information for sensing and sensor performance predictions.

FY 2006 Plans:

- Program transitions to new activities as noted in FY 2005 accomplishments.

FY 2007 Plans:

- Program transitions to new activities as noted in FY 2005 accomplishments.

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	FY 2005	FY 2006	FY 2007
NAVAL WARFARE SYSTEM-FOCUSED EFFORTS	10,355	0	0

This activity is the only applied research effort 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 activity. 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.

The transition to a revised activities structure in this PE resulted in a 100% decrease in FY 2006 and FY 2007. FY 2006 and out the activities are reflected elsewhere within this PE.

FY 2005 Accomplishments:

- Initiated and completed geoacoustic inversion techniques by verifying predictions of rough surface scattering theories with laboratory measurements. (NRL)
- Initiated and completed explosive placement pattern for air-dropped Mine Countermeasure (MCM) weapon systems using improved sediment shock physics models. (NRL)

The following efforts transition to new activity Coastal Geosciences/Optics/Biology in FY 2006:
- Continued innovative translator methods to apply mappings to xml request/response objects. (NRL)
- Continued to pursue techniques to allow determination of sediment microfabric and geotechnical properties and their exploitation in prediction of mine burial. (NRL)
- Continued development and testing of an underwater geo-magnetic noise model. (NRL)
- Initiated development of adaptive algorithms to improve MCM electro-optic sensor performance. (NRL)
- Initiated review of tools available to parse Web Services XML descriptions. (NRL)
- Initiated development of mapping functions to map the Advanced METOC Broker (AMB) schema to discovered Web

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Services schema. (NRL)
- Initiated collaboration with the Naval Postgraduate School on METOC ontology development. (NRL)
- Initiated enhancement to clustering algorithm to cluster features in 3D (e.g., geospatial X,Y location plus color) and determined clutter density. (NRL)
- Initiated design of human subject experiments to test user performance as a function of clutter in various displays (e.g., nautical, meteorological, aeronautical). (NRL)

The following efforts transition to new activity Ocean Acoustics in FY 2006:
- Continued to develop ability to optimize 3-D sonar search path by incorporating environmental uncertainty into the acoustic propagation estimates. (NRL)
- Continued analysis of experimental data sets to quantify the impact of dynamic oceanography on acoustic ASW system performance. (NRL)
- Initiated development of an integrated hydrodynamic/acoustic propagation modeling capability for littoral regions to predict acoustic ASW system performance in dynamic environments. (NRL)

The following efforts transition to new activity Marine Meteorology in FY 2006:
- Continued development of techniques for analysis and exploitation of through-the-sensor technology for rapid environmental assessment in support of Sea Strike. (NRL)
- Continued further development of techniques for improving high-resolution environmental fields required for chemical/biological warfare. (NRL)

The following effort transitions to new activity Physical Oceanography in FY 2006:
- Continued developing environmentally sensitive, physics-based decision tools, and measures of effectiveness in predictive systems. (NRL)

FY 2006 Plans:

- Program transitions to new activities as noted in FY 2005 accomplishments.

FY 2007 Plans:

- Program transitions to new activities as noted in FY 2005 accomplishments.

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	FY 2005	FY 2006	FY 2007
MARINE METEOROLOGY	0	9,359	10,003

The marine atmosphere affects most aspects of Naval operations. This activity develops observing technologies, models, numerical weather prediction (NWP) systems and tactical decision aids (TDA) that describe the atmospheric environment and its impacts on naval sensors and operations. This activity focuses on uniquely marine aspects of atmospheric science such as air-sea interaction, coupled ocean-atmosphere modeling, electromagnetic (EM) and electro-optic (EO) propagation, coastal meteorology, tropical cyclone prediction, and the use of remote sensing to obtain quantitative observations of atmospheric properties. Aspects of the atmospheric environment of particular interest include near-surface phenomena that affect refractivity, marine boundary layer dynamics that affect clouds, rain, visibility and fog, and processes that control tropical cyclone structure, track, and intensity. Objectives of this activity are improved NWP systems and TDAs that provide nowcast and forecast skill at global, regional, and tactical scales for operational support, sensor and system development, and performance prediction.

The transition from other activities in this PE resulted in a 100% increase in FY 2006 and FY 2007.

FY 2005 Accomplishments:

- Funded in other activities noted in the FY 2006 plans.

FY 2006 Plans:

Efforts noted below transitioned from BSE Concept Enabler, Ocean and Atmospheric Modeling/Prediction and Effects, and Naval Warfare System-Focused Efforts.

ONR
- Continue developments in atmospheric effects on electromagnetics and electro-optics because of the central importance of electromagnetic and electro-optic propagation to many modern warfare systems.
- Complete development of 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.

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NRL
- Complete development of techniques for analysis and exploitation of through-the-sensor technology for rapid environmental assessment in support of Sea Strike. (NRL)
- Complete development of a technique for improving high-resolution environmental fields required for chemical/biological warfare defense. (NRL)
- Initiate application of predictability concepts to optimize use of new-generation satellite data to target observation selection for maximum forecast impact in military areas of interest. (NRL)
- Initiate exploitation of optimal methods for capturing uncertainty of environmental predictions on regional and local scales for reliability estimates of tactical parameters. (NRL)

ONR and NRL
- Initiate effort to optimize rapid environmental assessment using coupled air-sea systems to support multiple warfare and mission areas, with a particular emphasis on Special Warfare. (ONR and NRL)

FY 2007 Plans:

ONR
- Continue development of an electro-optic (EO) propagation model that accounts for the atmospheric effects of near-surface refraction, scintillation, aerosol extinction, illumination and target, background and sensor characteristics for incorporation into EO tactical decision aids and for supporting warfare systems development.
- Initiate development and validation of the Advanced Propagation Model (APM) to account for atmospheric effects on electromagnetic (EM) radiation, in particular, by the addition of the capability to describe HF radio frequencies.
- Initiate development of methods for determination of refractivity from clutter (RFC) as an inverse method of obtaining the critical refractivity properties of the atmosphere that affect electromagnetic propagation.
- Initiate and complete the Rapid Transition Program (RTP) littoral warfare team adaptive sampling integration by combining bathymetry data from an the Remote Environmental Monitoring Units (REMUS) with other bathymetric data as input to a nearshore wave-hydrodynamic model for a nearshore nowcast. Forcing for nowcast is provided by the Distributed Integrated Ocean Prediction System (DIOPS).

NRL
- Continue application of predictability concepts to optimize use of new-generation satellite data to target observation selection for maximum forecast impact in military areas of interest. (NRL)

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- Continue exploitation of optimal methods for capturing uncertainty of environmental predictions on regional and local scales for reliability estimates of tactical parameters. (NRL)

ONR and NRL
- Continue effort to optimize rapid environmental assessment using coupled air-sea systems to support multiple warfare and mission areas, with a particular emphasis on Special Warfare. (ONR & NRL)
- Initiate the development of a real-time meteorological and oceanographic battlespace characterization capability (NOWCAST) that collects, processes and exploits on-scene environmental data for Rapid Environmental Assessment (REA). The system will combine high-resolution atmospheric forecast information with 4-D data assimilation of on-scene observations (radar, satellite, conventional observations, etc) for customized display at time and space scales relevant for tactical operation support (ONR & NRL).
- Initiate the development of global and mesoscale aerosol/radiation models that account for the major sources (desert dust, sea spray, biomass burning, industrial pollution) of visibility degradation in the atmosphere and integrate with numerical weather prediction systems for an aerosol predictive capability than can support militarily relevant time and space scales (ONR & NRL).

	FY 2005	FY 2006	FY 2007
PHYSICAL OCEANOGRAPHY	0	12,970	12,971

The goal of this activity is to develop Naval tactical uses of knowledge of the physics of the ocean within the battlespace environment. This is achieved through the development of predictive models of the water mass structure, waves, currents, and air-sea interactions and developing measurement/observation technology. Other applications utilize knowledge of the interaction of the water column hydrodynamics and the acoustics to predict the undersea transmission characteristics and sources of uncertainty in these statistics. Utilizing knowledge of the ocean surface physics, the physical oceanography program seeks to exploit the combination of remotely sensed data, in-situ data, and adaptively sampled data to optimize predictions of ocean currents and water column structure. These predictions, custom databases, adaptive sampling schemes and data programs serve Anti-Submarine Warfare (ASW), Naval Special Warfare (NSW), Sea-Basing, and mine warfare needs.

The transition from other activities in this PE resulted in a 100% increase in FY 2006 and FY 2007.

FY 2005 Accomplishments:

- Funded in other activities noted in the FY 2006 plans.

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FY 2006 Plans:

Efforts noted below transitioned from BSE Sensors and Data, Ocean and Atmospheric Modeling/Predictions and Effects, and Naval Warfare System-Focused Efforts.

ONR
- Continue undersea persistent surveillance effort with field efforts using ocean gliders to provide water column structure influencing acoustic propagation and allowing adaptation of sampling locations for optimal inputs to ocean predictive models. (ONR)
- 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. (ONR)

NRL
- Continue development of mass conserving baroclinic finite element models using discontinuous Galerkin methods. (NRL)
- Continue to extend current theory dealing with tidal variations in sound-speed to sound-speed events with strong range-dependence. (NRL)
- Complete the development of techniques, software and testing of a global relocation capability for ocean circulation models with a focus on the littoral ocean. (NRL)
- Complete study of coastally buoyant jets using a combination of observations and numerical models. (NRL)
- Complete the study of the effect of shoaling waves on ocean wave prediction. (NRL)
- Initiate the development of next-generation methods to estimate subsurface temperature and salinity from remotely-sensed surface and sparse in-situ observations (NRL)
- Initiate the development of a data assimilative nearshore modeling capability using measurements to guide hydrodynamic forecasts including data sampling strategies and model sensitivity to data. (NRL)
- Initiate the integration of hyperspectral imagery into underwater autonomous vehicles and derive river environmental properties through a combination of models and observations. (NRL)

ONR and NRL
- Continue studies of the monitoring and evaluation of ocean currents and water mass properties near topographic control points in marginal seas. (ONR and NRL)
- Continue developing environmentally sensitive, physics-based decision tools, and measures of effectiveness in predictive systems. (ONR and NRL)

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- Continue to develop improved ocean wave prediction, especially shoaling waves, based on the extensive basic research measurement programs in this area over the past decade. (ONR and NRL)
- Continue development in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander. (ONR and NRL)
- Continue developments in atmospheric and ocean model nowcast/forecast systems at a variety of scales (global, regional, semi-enclosed seas, local) including relocateable and nested models dependent on other priorities in this area. (ONR and NRL)
- 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 nests into the NCOM. (ONR and NRL)
- Continue development of predictive capability of internal wave affects on the battlespace, including affects on acoustic transmission. (ONR and NRL)

FY 2007 Plans:

ONR
- Continue undersea persistent surveillance effort with field efforts using ocean gliders to provide water column infrastructure influencing acoustic propagation and allowing adaptation of sampling locations for optimal assimilation into predictive ocean models. (ONR)
- Continue development of techniques to employ ocean models to perform complete 3-D acoustic simulations of space-time coherence of the acoustic field, enabling predictions of detection performance for acoustic systems. (ONR)
- Initiate and complete the development and implementation of new techniques for parameterizing fluxes of mass and energy across the air-sea interface in coupled ocean-atmosphere models, to improve operational predictions of the battlespace environment. (ONR)

NRL
- Continue development of mass conserving baroclinic finite element models using discontinuous Galerkin methods. (NRL)
- Continue to extend current theory dealing with tidal variations in sound-speed to sound-speed events with strong range-dependence. (NRL)
- Continue the development of next-generation methods to estimate subsurface temperature and salinity from remotely-sensed surface and sparse in-situ observations (NRL)
- Continue the development of a data assimilative nearshore modeling capability using measurements to guide hydrodynamic forecasts including data sampling strategies and model sensitivity to data. (NRL)

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- Continue the integration of hyperspectral imagery into underwater autonomous vehicles and derive river environmental properties through a combination of models and observations. (NRL)

ONR and NRL
- Continue studies of the monitoring and evaluation of ocean currents and water mass properties near topographic control points in marginal seas. (ONR and NRL)
- Continue to develop improved ocean wave prediction, especially shoaling waves, based on the extensive basic research measurement programs in this area over the past decade. (ONR and NRL)
- Continue developments in atmospheric and ocean model nowcast/forecast systems at a variety of scales (global, regional, semi-enclosed seas, local) including relocateable and nested models dependent on other priorities in this area. Incorporate high-resolution nests into the NCOM. (ONR and NRL)
- Continue development of predictive capabilities for internal wave effects in the battlespace, including acoustic transmission and buoyancy impacts. (ONR and NRL)

	FY 2005	FY 2006	FY 2007
COASTAL GEOSCIENCES/OPTICS/BIOLOGY	0	11,584	11,054

The goal of this activity is to determine the sources, distribution, and natural variability (concentration and properties) of optically important matters in the coastal ocean in support of Naval Mine, Undersea, and Special Warfare. Research investments in this activity support the development and testing of expendable and autonomous bioluminescence sensors, the continued development of extended range underwater imaging technologies, and algorithm development and testing for application to ocean color remote sensing from aircraft and space in order to characterize key features of the coastal battle space such as bathymetry, shallow-water bottom types, and the distribution of ocean water optical properties.

The transition from other activities in this PE resulted in a 100% increase in FY 2006 and FY 2007.

FY 2005 Accomplishments:

- Funded in other activities noted in the FY 2006 plans.

FY 2006 Plans:

Efforts noted below transitioned from BSE Concept Enablers, BSE Sensors and Data, and Naval Warfare System-

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Focused Efforts.

ONR
- Continue bioluminescence sensor effort with emphasis on needs of the Special Warfare (SPECWAR) forces and NAVOCEANO, 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 use space-based optical sensors as input for both active and passive optical MCM sensor performance prediction models.
- Continue development of innovative naval biosensors, biomaterials, and bioprocess technology.
- Continue programs for promising new biological and chemical sensors.
- Continue model development for diver visibility prediction in support of EOD and SPECWAR operations.
- Continue development of sensors to characterize diver visibility in support of EOD and SPECWAR operations.
- Complete programs in detection of fish by acoustic methods.
- Complete analysis of physics-based models for hyperspectral imaging of the ocean surface/near-surface to establish what information can be deduced about the optical properties of the ocean’s upper layers.
- Initiate engineering development and optimization of sea-floor sediment energy harvesting system for sustainable and autonomous powering of underwater sensor networks (coordinated with NRL Benthic Unattended Generator effort in this area).

NRL
- Continue design of human subject experiments to test user performance as a function of clutter in various displays (e.g., nautical, meteorological, aeronautical)(NRL).
- Continue to pursue techniques to allow determination of sediment microfabric and geotechnical properties and their exploitation in prediction of mine burial. (NRL)
- Continue development and testing of an underwater geo-magnetic noise model. (NRL)
- Continue development of adaptive algorithms to improve MCM electro-optic sensor performance. (NRL)
- Continue development of adaptive algorithms for image enhancement using an operational MCM electro-optic system and provide a demonstration. (NRL)
- Continue to refine algorithms that fuse sediment information extracted from operational sonars with historical sediment databases. (NRL)
- Continue development of gravity-based navigation by deploying a conventional gravimeter on a submarine. (NRL)
- Continue development of a Benthic Unattended Generator to power an autonomous ocean environmental profiler

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and provide demonstration.
- Continue development of Web Services registry search algorithms (NRL).
- Continue innovative translator methods to apply mappings to xml request/response objects (NRL).
- Continue process to refine NPS's MetOc ontology (NRL).
- Complete studies of ionospheric scintillation phenomena using satellite-satellite measurements providing near global coverage using the Scintillation and Tomography Receiver in Space (CITRIS) instrument to the Space Test Program Satellite (STPSAT1) mission. (NRL)
- Complete work on Advanced Techniques for Net-Centric Warfare to create a Naval Advanced METOC Broker to reliably find and broker data from new and ad-hoc METOC data providers to the warfighter in an automated manner. (NRL)
- Complete algorithm developments for novel navigation and communications among multiple (Unmanned Undersea Vehicles (UUVs). (NRL)
- Complete a technique using hyperspectral and motion imagery in the LZ which offer new possibilities for exploitation based on previous investigation. (NRL)
- Complete field test of a shipborne LIDAR system for near surface environmental characterization. (NRL)
- Complete AMB system architectural design and complete development of functions to parse xml and to map AMB schema to Web Services schema (NRL).
- Complete enhancement to clustering algorithm to cluster features in 3D and determine clutter density (NRL).
- Initiate investigation into appropriate measures of reliability of data and data sources discovered by AMB (NRL).
- Initiate experiments (and data collection) to test user performance as a function of display clutter. (NRL)
- Initiate development of small satellite calibration targets to determine atmospheric drag due to neutral density via LIDAR remote sensing. (NRL)

FY 2007 Plans:

ONR
- Continue development and testing in situ bioluminescence sensors and mapping bioluminescent properties.
- Continue efforts to use space-based optical sensors as input for both active and passive optical MCM sensor performance prediction models.
- Continue development of bio-sensors, -materials, and –process technology.

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- Continue development of sensors and models to characterize and predict diver visibility in support of EOD and SPECWAR operations.

NRL
- Continue experiments and demonstrations to allow for enhanced human performance via improved and automated data displays. (NRL)
- Continue efforts to increase understanding of sediment properties for mine burial prediction. (NRL)
- Continue to develop and test undersea noise models to improve sensor prediction performance in the littoral zone. (NRL)
- Continue development of adaptive algorithms to improve mine counter-measures (MCM) electro-optic sensor and system performance and provide a demonstration. (NRL)
- Continue development of gravity-based navigation by deploying a conventional gravimeter on a submarine. (NRL)
- Complete development of Web Services registry search algorithms (NRL).
- Complete innovative translator methods to apply mappings to xml request/response objects (NRL).
- Complete process to refine NPS’s MetOc ontology (NRL).
- Complete investigation into appropriate measures of reliability of data and data sources discovered by AMB (NRL).
- Complete experiments (and data collection) to test user performance as a function of display clutter. (NRL)
- Complete development of small satellite calibration targets to determine atmospheric drag due to neutral density via LIDAR remote sensing. (NRL)

ONR and NRL
- Continue development of a Benthic Unattended Generator to power an autonomous ocean environmental profiler and provide demonstration. (ONR and NRL)

	FY 2005	FY 2006	FY 2007
OCEAN ACOUSTICS	0	5,418	4,999

This activity is dedicated to the determination of the impact of the natural ocean environment on acoustic wave phenomena in support of Naval undersea warfare and underwater force protection operations. This activity studies underwater acoustic propagation, scattering from ocean boundaries, and ambient noise issues that impact the development and employment of acoustic systems. The Littoral Zone (LZ) has been the ocean environment of greatest interest. Aspects of this environment, that greatly impact underwater acoustic

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systems, are the shallow water included in the LZ, the consequent closeness and physical significance of the ocean bottom, and the complexities inherent to rapid changes of the ocean structure. The objectives of this program are met through measuring, analyzing, modeling and simulating, and exploiting ocean acoustic factors to gain advantage over potential adversaries using undersea acoustic systems. Results of this activity support acoustic sensor and system development, performance prediction, and tactical decision aids.

The transition from other activities in this PE resulted in a 100% increase in FY 2006 and FY 2007.

FY 2005 Accomplishments:

- Funded in other activities noted in the FY 2006 plans.

FY 2006 Plans:

Efforts noted below transitioned from Naval Warfare System-Focused Efforts.

NRL
- Continue to develop a method to optimize 3-D sonar search path by incorporating environmental uncertainty into the acoustic propagation estimates. (NRL)
- Continue development of an integrated hydrodynamic/acoustic propagation modeling capability for littoral regions to predict acoustic anti-submarine warfare (ASW) system performance in dynamic environments. (NRL)
- Complete analysis of experimental data sets to quantify the impact of dynamic oceanography on acoustic ASW system performance. (NRL)
- Initiate development of a tactical decision aid (TDA) that can predict the dynamic oceanographic characteristics of shallow-water internal waves and their effects on underwater acoustic signals. (NRL)

FY 2007 Plans:

NRL
- Continue to develop a method to optimize 3-D sonar search path by incorporating environmental uncertainty into the acoustic propagation estimates. (NRL)
- Continue development of an integrated hydrodynamic/acoustic propagation modeling capability for littoral regions to predict acoustic anti-submarine warfare (ASW) system performance in dynamic environments. (NRL)

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- Continue development of a tactical decision aid (TDA) that can predict the dynamic oceanographic characteristics of shallow-water internal waves and their effects on underwater acoustic signals. (NRL)

	FY 2005	FY 2006	FY 2007
NATIONAL OCEANOGRAPHIC PARTNERSHIP PROGRAM (NOPP)	0	9,714	9,691

This activity focuses on U.S. Navy investments in the National Oceanographic Partnership Program (NOPP). NOPP, established by the U.S. Congress (Public Law 104-201) in Fiscal Year 1997, is a unique collaboration among 15 federal agencies involved in conducting, funding, or utilizing results of ocean research. NOPP's value to the Navy derives from the capacity of the partnership to enable and ensure multi-agency efforts where such collaboration enhances efficiency or effectiveness, and/or reduces costs. Major areas of investment by NOPP include: development of an integrated coastal ocean observation system and development of sensors, communications and data acquisition, storage and processing tools required to effect it; modernization of ocean research and observation infrastructure; and, marine mammal-related research.

The transition from other activities in this PE resulted in a 100% increase in FY 2006 and FY 2007.

FY 2005 Accomplishments:

- Funded in other activities noted in the FY 2006 plans.

FY 2006 Plans:

Efforts noted below transitioned from BSE Concept Enabler.

ONR
- Continue marine mammal program on noise mitigation.
- Continue real-time forecasting system of winds, waves and surge in tropical cyclones.
- Continue The Partnership for Advancing Interdisciplinary Global Modeling (PARADIGM).
- Continue Global Ocean Data Assimilation Experiment (GODAE).
- Continue Hybrid Coordinate Ocean Model (HYCOM).
- Complete the Multi-Disciplinary Ocean Sensors for Environmental Analyses and Networks (MOSEAN).

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FY 2007 Plans:

ONR
- Continue marine mammal program on noise mitigation.
- Continue real-time forecasting system of winds, waves and surge in tropical cyclones.
- Continue The Partnership for Advancing Interdisciplinary Global Modeling (PARADIGM).
- Continue Global Ocean Data Assimilation Experiment (GODAE) including assessment of GODAE boundary conditions for use in coastal ocean predictions.
- Continue Hybrid Coordinate Ocean Model (HYCOM).
- Initiate wireless communications for the coastal ocean.
- Initiate new methods for detection of fish, fish populations and mapping of fish habitat.
- Initiate development of sensors for sustained, autonomous measurement of chemical or biological parameters in the ocean.

CONGRESSIONAL PLUS-UPS:

	FY 2005	FY 2006
BIOLUMINESCENCE TRUTH DATA MEASUREMENT AND SIGNATURE DETECTION	963	0

Continued research into the development of affordable, compact, efficient sensors that allowed ease of deployment and permit the rapid measurement of bioluminescence in the world’s oceans in order to create a database for future research. 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.

	FY 2005	FY 2006
CARBON NANOTUBE-BASED RADIATION HARD NON-VIOLATILE RAM	4,341	0

Effort supported developmental Carbon Nanotube-Based Radiation Hard Non-Volatile RAM.

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	FY 2005	FY 2006
COASTAL ENVIRONMENTAL EFFECTS	4,051	0

Effort supported next generation of technical capabilities to acquire, collect, detect and analyze contaminants in the coastal environment.

	FY 2005	FY 2006
COASTAL MASINT	0	4,200

This effort supports coastal MASINT research.

	FY 2005	FY 2006
CONTINUATION OF RESEARCH IN OCEAN TECHNOLOGY AND AUTONOMOUS MARINE SENSORS	0	4,800

This effort supports continuation of research in ocean technology and autonomous marine sensors research.

	FY 2005	FY 2006
EXTENDED CAPABILITY UNDERWATER OPTICAL IMAGING	963	0

Effort continued research into 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 2005	FY 2006
INTEGRATED LITTORAL SENSOR NETWORK	963	1,800

The central goal of the Integrated Littoral Sensor Network was to integrate scientific resources and understanding so as to enable rapid and effective response to potential terrorist threats as well as to episodic natural or accidental hazards, such as severe storms, harmful algae blooms or toxic spills.

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Deliverables to the Navy were a portable suite of sensors, models and informatics techniques for detection, diagnosis, and predictions of manmade and natural water-borne pathogens and toxins in ports, bays and littoral waters.

	FY 2005	FY 2006
NEW JERSEY COASTAL OBSERVING SYSTEM	0	1,000

This effort supports the New Jersey Coastal Observing System.

	FY 2005	FY 2006
OCEANOGRAPHIC SENSORS FOR MCM/AUTONOMOUS MARINE SENSORS	2,412	0

Continued research into the development of small, low-power sensors to be used on small autonomous underwater vehicles designed for covert characterization of denied areas, thereby it gave the Navy a new capability in MCM operations.

	FY 2005	FY 2006
SOUTHEAST COASTAL OCEAN OBSERVING SYSTEM (SEACOOS)	4,822	1,625

FY 2005 - This effort continued funding for SEACOOS. It enhanced data access to significantly improve the understanding of atmospheric, oceanic and coupled behaviors in the southeastern U.S., Bahamas, northern Caribbean basin and in the surrounding larger-scale systems.

FY 2006 - This effort supports the Southeast Coastal Ocean Observing System.

	FY 2005	FY 2006
SURA COASTAL OCEAN OBSERVATION PROGRAM (SCOOP)	2,506	0

The Southeastern Universities Research Association (SURA) Coastal Ocean Observing Prediction (SCOOP) Program worked towards the goal of providing a national system for observing and predicting the myriad events that occur in America's vital coastal waters. The SCOOP proposed to take on the task of integrating diverse

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systems at the national level. Deliverables were software modules for data transport and data translation, computing storage & services, numerous demonstrations, and program integration.

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.