Exhibit R-2, PB 2010 Navy RDT&E Budget Item Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research					R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH					
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	52.499	51.538	48.750						Continuing	Continuing
0000: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	52.499	51.538	48.750						Continuing	Continuing

A. Mission Description and Budget Item Justification

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Jan 2007). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This 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.

Exhibit R-2, PB 2010 Navy RDT&E Budget Item Justification	DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	**R-1 ITEM NOMENCLATURE** PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH

B. Program Change Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Previous President's Budget	53.967	47.278	51.422	
Current BES/President's Budget	52.499	51.538	48.750	
Total Adjustments	-1.468	4.260	-2.672	
Congressional Program Reductions		-0.140		
Congressional Rescissions				
Total Congressional Increases		4.400		
Total Reprogrammings	-1.166			
SBIR/STTR Transfer	-0.302			
Program Adjustments			-2.108	
Rate/Misc Adjustments			-0.564	

Congressional Increase Details ($ in Millions)	FY 2008	FY 2009
Project: 9999, **AUTONOMOUS MARINE SENSORS AND NETWORKS FOR RAPID LITTORAL ASSESSMENT**	1.549	1.596
Project: 9999, **AUTONOMOUS UNDERSEA VEHICLE APPLICATIONS CENTER**	1.166	0.000
Project: 9999, **EXTENDED UNDERWATER OPTICAL IMAGING**	0.000	1.994
Project: 9999, **LITTORAL BATTLESPACE SENSING (LBS) & AUTONOMOUS UNDERWATER VEHICLE SYSTEM (UAV) PROGRAM**	0.965	0.798
Project: 9999, **UNDERWATER ACOUSTIC IMAGING FOR MARITIME DOMAIN AWARENESS**	0.967	0.000

Change Summary Explanation

Technical: Not applicable

Schedule: Not applicable

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH					PROJECT NUMBER 0000	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
0000: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	52.499	51.538	48.750						Continuing	Continuing

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 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.

B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
COASTAL GEOSCIENCES/OPTICS	9.124	6.169	5.926	
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				

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	PROJECT NUMBER 0000

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
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. Decrease from FY 2008 to FY 2009 is due to a realignment of funding to the Marine Mammal and Biology R-2 Activity in support of CNO requirements, and to reflect an overall trend in program direction toward ocean science. *FY 2008 Accomplishments:* - 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 development of innovative naval biosensors, biomaterials, and bioprocess technology. - Continued 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). - Continued development of bio-sensors, -materials, and –process technology, with a focus on development of marine mammal pathogen diagnostics (for bacteria, viruses and fungal infections) to support Navy's Fleet Marine Mammal Systems. (Transfers to 0602236N in FY08) - Continued 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). (Transfers to 0602236N in FY08) - Continued a program to develop systems to monitor marine mammals during fleet activities using 1) passive acoustic sensors on autonomous underwater vehicles and 2) through radar signal processing algorithms.				

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH			PROJECT NUMBER 0000	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Continued behavioral response studies to develop threshold criteria for marine mammal reactivity to naval sonars and other manmade sound sources of interest. - Continued development and testing of an underwater geo-magnetic noise model. - Continued development of adaptive algorithms to improve MCM EO sensor performance. - Continued to refine algorithms that fuse sediment information extracted from operational sonar with historical sediment databases. - Continued development of a Benthic Unattended Generator to power an autonomous ocean environmental profiler and provided demonstration. - Continued experiments (and data collection) to test user performance as a function of display clutter. - Continued development of small satellite calibration targets to determine atmospheric drag due to neutral density via Light Detection and Ranging (LIDAR) remote sensing. - Initiated at-sea demonstration of radar and acoustics systems to monitor marine mammals in fleet activities. This effort moves to the Marine Mammals and Biology R2 activity in FY 2009. - Initiated efforts to develop visible/near infrared hyperspectral imagery algorithms for autonomous, near real time, retrieval of environmental products, such as diver visibility, bottom type and reflectivity, and bathymetry. - Initiated efforts to develop automatic coordination and utilization of distributed web services. - Completed refining algorithms that fuse sediment information extracted from operational sonars with historical sediment databases. - Completed development of a Benthic Unattended Generator to power an autonomous ocean environmental profiler and provide demonstration. *FY 2009 Plans:* – Continue all efforts of FY 2008 less those noted as completed above. - Complete tracking analysis of small satellite calibration targets to determine atmospheric drag due to neutral density via LIDAR remote sensing. - Initiate effort to understand and predict how power harvesting from the seabed is controlled by sediment geochemistry, microbiology, physical properties, and energetics.					

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH			PROJECT NUMBER 0000	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Initiate effort to develop and evaluate an integrated multi-sensor suite, including a small microflow cytometer, to characterize optical and biological properties of subsurface particle layers in coastal waters using unmanned underwater glider technology. - Initiate effort to develop an intelligent decluttering algorithm (or system of algorithms) that accounts for both global and local clutter metrics in complex, multivariate displays. - Initiate effort to develop a next generation atmospheric correction algorithm which will greatly enhance ocean passive retrievals including ocean color and visibility, bathymetry and sea surface temperature. *FY 2010 Plans:* - Continue all efforts of FY 2009 less those noted as completed above. - Complete effort to develop visible/near infrared hyperspectral imagery algorithms for autonomous, near real time, retrieval of environmental products, such as diver visibility, bottom type and reflectivity, and bathymetry. - Complete effort to develop automatic coordination and utilization of distributed web services. - Complete 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. - Initiate development of riverine expert system for environmental characterization.					
MARINE MAMMALS AND BIOLOGY This activity consolidates and expands research conducted in previous years in Coastal Geosciences/ Optics and the Physical Oceanography Activities and expands these efforts. The sensitivity of Marine Mammals to sound produced by Naval operations and training will continue. This program is to assure that Navy decisions can be based on scientifically defensible positions. The goal of this activity is to support: (1) marine mammal research related to understanding impacts of sound (especially sonar) on marine mammal behavior, hearing, physiology, distributions and ecology; (2) development and testing of new technologies for the detection of marine mammals at sea; (3) research on the bio-acoustic properties, use of sound for detection of, and effects of sound on fish and lesser marine		0.000	5.477	4.999	

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	PROJECT NUMBER 0000

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
organisms; and (4) research on optically important biota in the coastal ocean in support of Naval Mine, Undersea, and Special Warfare (including oceanic bioluminescence and the development and testing of bioluminescence sensors). The marine mammals research conducted in this PE represents part of a total effort executed in coordination with complementary research performed in PE 0602747N. FY 2009 reflects the realignment of funds from the Coastal Geosciences/Optics R2 Activity to fund expansion of the marine mammal noise study/mitigation effort per CNO requirement and to reflect an overall trend in program direction toward ocean sciences. *FY 2009 Plans:* - Complete an accelerated effort for marine mammal detection involving signal processing of surface radar and the use of autonomous vehicles to allow passive acoustic and electromagnetic detection and monitoring of marine mammals off ranges during fleet ASW experimentation exercises and demonstrations when sound is transmitted underwater. (This effort transitioned from the Coastal Geosciences/Optics R2 activity). - Initiate multi-investigator, coordinated field research to test responses of marine mammals (especially beaked whales) to controlled sound exposures. - Initiate development of new technologies for detection and localization of marine mammals, including (but not restricted to) gliders equipped with passive acoustic sensors, radar and thermal imagery. - Initiate research examining hearing sensitivity of marine mammals (including temporary and permanent threshold shifts). - Initiate research efforts examining distributions and abundances of marine mammals relative to prey fields and basic oceanographic parameters. - Initiate development of and evaluate models that predict time- and space-dependent sound fields produced by anthropogenic noise sources and mammal responses to the noise. - Initiate development and testing of multi-frequency acoustic technologies for detection, identification and enumeration of fish. - Initiate research to examine sensitivity of fish to anthropogenic sound.				

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH			PROJECT NUMBER 0000	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Initiate research leading to better predictability of bioluminescent and pigment-bearing planktonic organisms. *FY 2010 Plans:* - Continue all efforts of FY 2009 less those noted as completed above.					
MARINE METEOROLOGY 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, EM and EO propagation, coastal meteorology, Tropical Cyclone (TC) 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 TC 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. *FY 2008 Accomplishments:* - Continued developments in atmospheric effects on EMs and EOs because of the central importance of EM and EO propagation to many modern warfare systems. - Continued development of an 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. - Continued 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.		11.459	11.409	11.063	

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	PROJECT NUMBER 0000

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continued exploitation of optimal methods for capturing uncertainty of environmental predictions on regional and local scales for reliability estimates of tactical parameters. - Continued program to develop the ability to assimilate data from the next generation of operational weather satellites to benefit real-time analysis of the battlespace environment as well as improving the global forecasting skill. - Continued development and validation of the Advanced Propagation Model to account for atmospheric effects on EM radiation, in particular, by the addition of the capability to describe high frequency radio frequencies. - Continued development of new methods, which account for a wider range of atmospheric conditions, for determination of refractivity from clutter as an inverse method of obtaining the critical refractivity properties of the atmosphere that affect EM propagation. - Initiated effort to exploit probabilistic parameter ensembles for model improvement and construct a basis for observation-informed stochastic model integration. - Initiated effort to improve understanding of atmospheric physical processes in the Arctic. - Continued 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. - Continued 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. 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. - Continued 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 that can support militarily relevant time and space scales. - Continued the development and validation of a next-generation TC model that can analyze, initialize, and predict TC position, structure and intensity, using a high-resolution (< 3 km) mesoscale model. The development will leverage emerging data assimilation and modeling techniques as well as observational results from the scientific community to build upon existing modeling capabilities.				

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH			PROJECT NUMBER 0000	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Initiated development of methods to retrieve and assimilate remotely-sensed aerosol data into aerosol prediction models. - Merged multiple data sources (radar and optical) of resident space objects (from 1st flight) for improved precision orbit determination (~25%) and prediction (~15%). *FY 2009 Plans:* - Continue all efforts of FY 2008. - Complete the development and validation of a next-generation TC model that can analyze, initialize, and predict TC position, structure and intensity, using a high-resolution (< 3 km) mesoscale model. The development will leverage emerging data assimilation and modeling techniques as well as observational results from the scientific community to build upon existing modeling capabilities. *FY 2010 Plans:* - Continue all efforts of FY 2009 less those noted as completed above. - Complete development of new methods, which account for a wider range of atmospheric conditions, for determination of refractivity from clutter as an inverse method of obtaining the critical refractivity properties of the atmosphere that affect EM propagation. - Complete 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. - Complete 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. 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. - Complete effort to exploit probabilistic parameter ensembles for model improvement and construct a basis for observation-informed stochastic model integration. - Complete effort to improve understanding of atmospheric physical processes in the Arctic. - Complete tracking analysis of small satellite calibration targets to determine atmospheric drag due to neutral density via LIDAR remote sensing.					
NATIONAL OCEANOGRAPHIC PARTNERSHIP PROGRAM (NOPP)		9.782	9.400	9.089	

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	PROJECT NUMBER 0000

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
This activity focuses on US Navy investments in the NOPP. NOPP, established by the US 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 affect it, modernization of ocean research and observation infrastructure, and marine mammal-related research. *FY 2008 Accomplishments:* – Continued marine mammal program on noise mitigation – Continued The Partnership for Advancing Interdisciplinary Global Modeling. – Continued Global Ocean Data Assimilation Experiment (GODAE) including assessment of GODAE boundary conditions for use in coastal ocean predictions. - Continued new methods for detection of fish, fish populations and mapping of fish habitat. - Continued development of sensors for sustained, autonomous measurement of chemical or biological parameters in the ocean. - Continued marine mammal program on methods for detection and tracking of marine mammals and mapping their habitat. - Continued and completed wireless communications for the coastal ocean. - Completed Hybrid Coordinate Ocean Model (HYCOM). *FY 2009 Plans:* – Continue all efforts of FY 2008 less those noted as completed above. *FY 2010 Plans:* – Continue all efforts of FY 2009. - Initiate effort to develop global ocean models with sufficient resolution to accurately simulate tides and internal waves to improve the fidelity of ocean prediction systems.				

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH			PROJECT NUMBER 0000	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Continue real-time forecasting system of winds, waves and surge in TCs. – Complete The Partnership for Advancing Interdisciplinary Global Modeling. – Complete Global Ocean Data Assimilation Experiment (GODAE) including assessment of GODAE boundary conditions for use in coastal ocean predictions. - Complete new methods for detection of fish, fish populations and mapping of fish habitat.					
OCEAN ACOUSTICS 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 systems, are the shallow water included in the Littoral Zone, 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. Increase from FY 2009 to FY 2010 reflects increased level of investment in ocean acoustics research. *FY 2008 Accomplishments:* - Continued development of an integrated hydrodynamic/acoustic propagation modeling capability for littoral regions to predict acoustic ASW system performance in dynamic environments. - Continued development of a TDA that can predict the dynamic oceanographic characteristics of shallow-water internal waves and their effects on underwater acoustic signals. - Continued development of a validated, physics-based processing algorithm that diagnoses acoustic performance directly from oceanographic data.		6.016	6.078	7.450	

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH			PROJECT NUMBER 0000	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Continued development of a set of physics-based environmental acoustic metrics to evaluate the predictions of TDAs that are used in planning asset allocation and placement of distributed Autonomous Undersea Vehicles (AUVs) in a time evolving scenario. - Continued development of improved performance predictions for sonar surveillance systems that utilize horizontal line arrays operating in shelf-break environments and relate horizontal-array signal gain and coherence length to the statistics and scale lengths of transverse environmental inhomogeneities. - Continued development of glider ocean sampling strategies to minimize acoustic detection range uncertainty for anti-submarine warfare predictions. - Continued development of a broadband, bistatic reverberation time-series simulator for range-dependent underwater environments. - Continued development of an ocean magnetic prediction system for magnetic fields generated by high amplitude internal waves, internal bores, and internal solitary waves. - Demonstrated in Rim of the Pacific 2008 (RIMPAC08) new ASW metrics to plan ASW mission and assess ASW system performance. *FY 2009 Plans:* – Continue all efforts of FY 2008. *FY 2010 Plans:* – Continue all efforts of FY 2009. - Complete development of glider ocean sampling strategies to minimize acoustic detection range uncertainty for anti-submarine warfare predictions. - Complete development of a broadband, bistatic reverberation time-series simulator for range-dependent underwater environments.					
PHYSICAL OCEANOGRAPHY The goal of this activity is to develop naval tactical uses of knowledge of the physics of the ocean within the BSE. 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		11.471	8.617	10.223	

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	PROJECT NUMBER 0000

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
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 ASW, Naval Special Warfare (NSW), Sea-Basing, and mine warfare needs. Decrease from FY 2008 to FY 2009 is due to a realignment of funding to the Marine Mammals and Biology R2 Activity in support of CNO requirements, and to reflect an overall trend in program direction toward ocean science. Increase from FY 2009 to FY 2010 reflects increased level of investment in physical oceanography. *FY 2008 Accomplishments:* - 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 of mass conserving baroclinic finite element models using discontinuous Galerkin methods. - Continued to extend current theory dealing with tidal variations in sound-speed to sound-speed events with strong range-dependence. - Continued the development of a data assimilative nearshore modeling capability using measurements to guide hydrodynamic forecasts including data sampling strategies and model sensitivity to data. - Developed new ocean mixed-layer algorithms for generation of synthetic profiles which has led to the operational implementation of a new system Navy Ocean Sound Speed Prediction (NOSSP) system at the Naval Oceanographic Office. - Continued the integration of hyperspectral imagery into underwater autonomous vehicles and derive river environmental properties through a combination of models and observations. - Continued 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 BSE.				

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	PROJECT NUMBER 0000

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continued development and testing of acoustic communications, disposable environmental instruments, and Unmanned Undersea Vehicles (UUV) and gliders for NSW mission support. - Continued developing Delft3-D-Coupled Ocean Atmosphere Mesoscale Prediction System (COAMPS) to include new options for riverine input and transport and behavior of contaminants in support of NSW mission planning. - Continued development of the knowledge layer of the internal wave tactical decision aid. - Continued development and testing of optimizing remote environmental monitoring units and other autonomous devices for NSW-Meteorological and Oceanographic Command (METOC) uses in assessing METOC conditions and providing data for assimilation. - Continued development and testing of glider uses in ASW METOC, adaptive sampling, and NSW support. - Continued the development of synthetic aperture radar and hyperspectral imagery exploitation for NSW and Marine Expeditionary Forces as well as the support of new riverine units. - Continued studies of the monitoring and evaluation of ocean currents and water mass properties near topographic control points in marginal seas. - 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. - Continued 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. - Continued development of predictive capability of internal wave affects on the battlespace, including affects on acoustic transmission. - Continued the development of the coupled Delft3d-COAMPS model within the larger naval forecast system for use in NSW mission planning - Continued the development of adaptive sampling algorithms for minimizing acoustic uncertainty using persistent, reconfigurable sampling by UUVs. - Completed Undersea Persistent Surveillance (UPS) effort with field experimentation using ocean gliders to provide water column structure influencing acoustic propagation and allowing adaptation in sampling locations for optimal inputs to ocean predictive models; major in-water experiment in late summer/early				

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH			PROJECT NUMBER 0000	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
fall 2007. The research products from this effort will transition to the Innovative Naval Prototype (INP) Persistent Littoral Undersea Surveillance (PLUS) effort in PE 0603747N. - Completed 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 battle space environment. - Completed Phase 1 of the development of adaptive sampling algorithms for minimizing acoustic uncertainty using persistent, reconfigurable sampling by UUVs. - Initiated on-board processing of METOC data on gliders/UUV for exfiltration consistent with operational concept of operations. - Initiated the custom installation of adaptive sampling algorithms for minimizing acoustic uncertainty using persistent, reconfigurable sampling by UUVs using Naval Oceanographic (NAVO) modeling systems. - Initiated effort to develop a coupled, high-resolution, comprehensive ocean prediction system for the study of complex air-sea processes. *FY 2009 Plans:* – Continue all efforts of FY 2008 less those noted as completed above. - Complete development and testing of glider uses in ASW METOC, adaptive sampling, and NSW support. *FY 2010 Plans:* - Continue all efforts of FY 2009 less those noted as completed above. - Complete effort to develop a coupled, high-resolution, comprehensive ocean prediction system for the study of complex air-sea process. - Complete development and testing of glider uses in ASW METOC, adaptive sampling, and NSW support.					

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	PROJECT NUMBER 0000

C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
PE 0601153N/Defense Research Sciences									Continuing	Continuing
PE 0602114N/Power Projection Applied Research									Continuing	Continuing
PE 0602123N/Force Protection Applied Research									Continuing	Continuing
PE 0602235N/Common Picture Applied Research									Continuing	Continuing
PE 0602271N/RF Systems Applied Research									Continuing	Continuing
PE 0602601F/Space Technology									Continuing	Continuing
PE 0602747N/Undersea Warfare Applied Research									Continuing	Continuing
PE 0602782N/Mine and Expeditionary Warfare Applied Research									Continuing	Continuing
PE 0602784A/Military Engineering Technology									Continuing	Continuing
PE 0603207N/Air/Ocean Tactical Applications									Continuing	Continuing
PE 0603271N/RF Systems Advanced Technology									Continuing	Continuing
PE 0603401F/Advanced Spacecraft Technology									Continuing	Continuing

Exhibit R-2a, PB 2010 Navy RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602435N OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	PROJECT NUMBER 0000

PE 0603747N/Undersea Warfare Advanced Technology		
PE 0603782N/Mine and Expeditionary Warfare Advanced Technology	Continuing	Continuing
PE 0604218N/Air/Ocean Equipment Engineering	Continuing	Continuing

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.