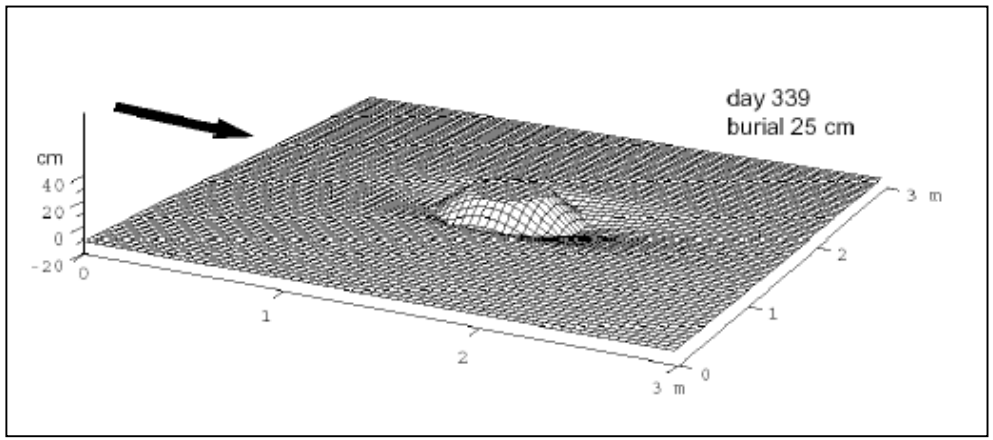
Task 4: Predicting the Mobility and Burial of Underwater UXO

Y0817 Pollution Abatement Ashore Program
Program Reviews

3 June 2004



NFESC, Code 51
tel: (805) 982-6070

Project Coordination

- **Naval Facilities Engineering Service Center**
  - Barbara Sugiyama, Project Manager
  - Alexandra DeVisser, Ocean Engineering Project Lead
- **Sound & Sea Technology, Inc.**
  - Jeff Wilson, Project Manager & Field Testing
  - Dallas Meggitt, Model Validation Technology
- **Dr. Scott A. Jenkins Consulting**
  - Dr. Scott Jenkins, UXO Mobility Model & Calibration
- **Naval Base Ventura County**
  - Allen Adams, NAS Point Mugu Environmental
- **Naval Station, Everett, WA**
  - John Miller, Pacific Beach Environmental

Objective and Requirements

Objective: Predict displacement-burial cycle of UXO in littoral waters from introduction to final entombment.

- **Errant projectiles and bombs from bombing and gunnery ranges**
- **UXO lost during ammunition transfer operations and training exercises**
- **Spatial distribution and number is uncertain for specific sites**
- **Survey of poorly specified areas is time consuming and expensive**
- **Modeling can guide surveys by defining area and depth requirements**
- **UXO clearance decisions based on statistical confidence**

Approach

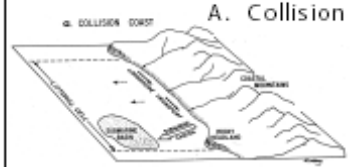
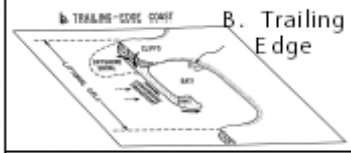
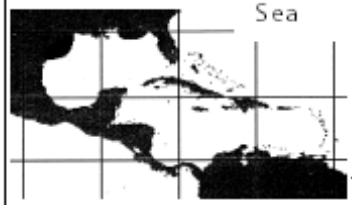
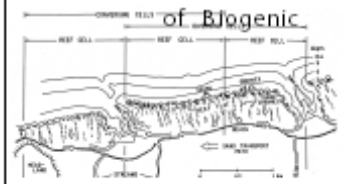
- **Based on Vortex/Lattice Model developed for ONR by SIO to predict Mine Burial in worldwide generic coastal waters**
- **Existing mine model is being adapted to produce the "UXO Mobility Model"**
- **Field tests will cover gamut of seasonal shoreline changes**
- **Mobility adaptation of Model will run in two modes:**
  - Deterministic: for direct comparison with observations using measured parameters
  - Statistical (Monte Carlo): using long-term site-specific climatic parameters to determine migration distance and final entombment

Technology Description
Underwater UXO Mobility and Burial Model

- **Input**
  - Calibrated generic coastal site classification: provides shore profile, sediment types, and selectable seasonal forcing environment options
  - Sub-category: adapts for sheltered water with tidal prism and captured runoff (deposition environment)
  - UXO site coordinates provide local bathymetry and major coastal runoff locations
  - Current meter time series data for calibration
- **Output**
  - Time variable UXO displacement burial depth (what will NOT move)
  - UXO migration rates, direction, and distances for UXO that does move

Technology Description

Coastal Classification System with Synthesized Model Input Parameters

Coastal Type	Boundary Conditions					Model Parameters		
	Morphology (Example)	Sediment Source	Sediment Sink	Closure Depth	Littoral Cell Dimensions	Grid Cell	Grain Size	Bed Roughness, n_0
 A. Collision	Narrow-Shelf Mountainous Coastal Bluffs (Cailfornia)	Rivers & Bluff Erosion	Submarine Canyons	15 - 18 m	Longshore: 50 km Cross Shore: 1 - 5 km	Farfield: 70 - 90 m Nearfield: 1 - 4 cm	Beach: 0.2 - 0.3 mm Shelf: 0.06 - 0.10 mm	0.5 - 3 cm
 B. Trailing Edge	Wide-Shelf Plains (Duck, NC)	Headlands & Shelves	Roll-Over Shoals Spit-Extension	10 -13 m	Longshore: 100 km Cross Shore: 30 - 50 km	Farfield: 40 - 80 m Nearfield: 2 - 7 cm	Beach: 0.2 - 0.4 mm Shelf: 0.06 - 0.15 mm	0.8 - 5 cm
 C. Marginal Sea	a) Narrow-Shelf Mountainous (Korea) b) Wide-Shelf Plains (Corpus Christi) c) Deltaic tideless (Mississippi) d) Deltaic tidal (Bangladesh) Wide-Shelf	Rivers & Deltas	a) Canyons b) Beaches & Barriers c) Delta & Shelf d) Delta Islands, flats, canyons	Narrow shelf: 7 - 10 m Wide shelf: 4 - 7 m Delta: 3 m	Longshore: a) 5-10 km b) 100 km c) 5-200 km d) var Cross Shore: a) 1 - 5 km b) 50 km c) 20-80 km d) var	Farfield: 10 - 20 m Nearfield: 1 - 3 cm	Beach: 0.06 - 0.21 mm Shelf: 0.01 - 0.09 mm Delta: .005 - .05 mm	a-d) 0.1 - 1 cm d) sand waves
 E. Coral Reef Form of Biogenic	Coral Reef Island (Hawaii)	Carbonate Reef Material Volcanic Headlands	Pocket Beaches & Awa Channels to the Shelf	Reef Platform	Longshore: ~2 km Cross Shore: 0.5 km	Farfield: 100 - 150 m Nearfield: 1 - 20 cm	Beach: 0.2 - 0.4 mm Shelf: 0.03 - 0.1 mm	Reef Platform ~1 m Offshore 1 - 15 cm

Technology Description

Initial Vortex/Lattice Model Calibration and Verification Testing

- Model calibration and validation required for each generic category of critical UXO sites.
- Test planned for highest priority Collision Coastline Coastal Classification under the Y0817 program
- Pt. Mugu, CA, Drifter Field Test
  - Inert UXO surrogates (20mm) deployed in surf zone (8-30ft)
  - Lagrangian Drifter Technique used to determine horizontal and vertical divergence
  - Direct deterministic comparison with model predictions
  - Comparisons of model/observations made wrt season

Technology Description
UXO Test Objects

- **Small Caliber Shells (< 1 in. dia.): primarily 30/50 cal. & 20mm rounds**

- **Large Caliber Projectiles (> 1 in. dia.): primarily Navy 5” (21” to 26” long)**

- **Aerial bomb shapes, small caliber UXO in cases and similar shapes will be tested in follow-on work under the ESTCP program**

Technology Description Y0817
Lagrangian Drifter Field Tests (Point Mugu)

- Approach
  - Many samples (100), steep Collision Coastal beach
  - Only tracked by date and location found on the beach
  - Inexpensive but only gives broad statistics and requires high-energy storm to beach samples (long-term test).
- Status
  - In progress.
- Permitting
  - NEPA
  - CATX

Technology Description Y0817
Measurement Method Field Test (Pacific Beach, WA)

- Approach
  - Direct measurement of individual, large samples by both acoustic and tether tracking
  - Conducted on high-energy, high tide range, flat beach (Collision Coastal)
  - Compares tracking methods and refines measurement process.
  - Gives rapid results (one tide cycle), direct validation of model for the surf transit phase of movement, fully instrumented waves.
- Status
  - Testing, May 2004.
- Permitting
  - Scientific Research Permit
  - DNR
  - NAVSTA Everett
  - ACOE, NWP
  - DE
  - JARPA
  - Tribal Nations
  - OCNMS

Technology Description
ESTCP Dem/Val Field Tests

- Calibrates model for remaining major coastal conditions (e.g., trailing edge, biogenic)
- Atlantic (Duck, NC) and Hawaii (TBD)
- Uses both Lagrangian and best direct-measure methods

Benefits: Payback

- Cost savings to CNO by leveraging off of existing mine burial work
- Difficult to calculate ROI for active range
- Range Sustainability Project (not Cleanup Project)
- Example ROI Calculation* for entire underwater UXO Program (uses an average annual number from a 3-year horizon and dividing by initial cost):

$$ROI = \frac{\text{net cost for 3 sites}}{\text{total investment}} = \frac{2{,}764.2\,\text{M} - 1.32\,\text{M}}{1.32\,\text{M}} = 1{,}335.5$$

* Mare Island, Vieques, Kaho'olawe

Milestones and Major Deliverables

ID	Task Name	FY01	FY02				FY03			
	Project Start: Aug 2001, Project Complete: Sep 2004	**Q1**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
	UXO MOBILITY MODEL NAVY PROGRAM									
1	**PHASE ONE - Parameter Definition**									
2	Survey of Transport Mechanisms									
3	Parameter Definition									
4	**PHASE TWO - Model Modification & Field Work**									
5	**Navy Program Planning**									
6	Draft Updated Phase Two Plan									
7	NFESC review and approve Plan									
8	SST contract to SAJ									
9	Draft Combined UXO Mobility Model Program Plan									
10	Conduct peer review									

Milestones and Major Deliverables

ID	Task Name	FY03				FY04			
	Project Start: Aug 2001, Project Complete: Sep 2004	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
	UXO MOBILITY MODEL NAVY PROGRAM								
11	**UXO Mobility Model Modifications**								
12	Calibration and Verification Testing (Pt. Mugu, CA)								
13	Modify Vortex Model (steps a-c)								
14	Use Model to plan MMFT								
15	Conduct hindcast validation (Duck, Lake Erie, etc.)								
16	Calibration and Verification Testing (Pacific Beach, WA)								
17	Check model against MMFT results								
18	Deliver Draft UXO Mobility Model								
19	Modify Vortex Model (steps d-f)								
20	Validate Model against MMFT intitial measures								
21	Validate Model against MMFT long-term data								
22	Document deterministic results - Collision Coastal								
23	Model Modification Report, Software Tools, & Numerical Model								

Technical Accomplishments

- **Ranked Navy UXO sites (operational/BRAC/FUDS) and categorized them by hydrodynamic and sediment types (FY03)**

- **Adapted VORTEX model (FY03-04):**
  - Develop code modification to run model backwards from initial state of complete burial
  - Develop I/O file structure to accommodate short time step simulations for small caliber munitions
  - Develop code for moveable nearfield gridding schemes for small caliber munitions
  - Modified code to initialize population density of UXO according to layers of impact burial
  - Draft report (May 2004).

Technical Accomplishments

- Acquired/Fabricated dummy ordnance (FY03-FY04)
- Calibrate VORTEX model for selected test site and deploy and track ordnance movement over seasonal and storm driven mobility/burial sequences (FY03-04)
- MMFT planning for Pacific Beach, WA (FY04)
- ESTCP proposal accepted for outyear efforts

Work to Completion

- Complete Measurement Method Field Test (Pacific Beach, WA)
- Validate Model against MMFT intitial measures
- Validate Model against MMFT long-term data
- Document deterministic results - Collision Coastal
- Model Modification Report, Software Tools, & Numerical Model
- Meet with risk assessment modeling experts to incorporate results into RA model (e.g., ARAMS)

Logic Model

Navy Benefits	Mobility and Burial Model for collision coastal category.
Customer Capability	Predict UXO mobility wrt type and location for collision coastal category.
Products	Model as assessment tool (statistically or deterministically).
Project Milestones	Model Modification Report, Software Tools, Numerical Model (Sept 2004).

Summary

- **Mobility and Burial Model being developed, calibrated, and validated for collision coastal category**
- **Model demonstration/validation will be conducted under ESTCP**
- **Model can be used as assessment tool (statistically or deterministically)**
- **Delineation of clearance areas and UXO subsidence depths have potential for cost savings.**