SUSTAINABLE RANGES
Characterization, Fate & Transport, Effects

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Improving Mission Readiness Through Environmental Research

The Challenge

Tools needed to integrate the two are limited.

The database upon which to develop those tools is also limited.

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Military Readiness

- Training Range Activities (HE)
  - Artillery/Mortar
  - Antitank
    - Battleruns (pop-up targets)
    - Antitank rockets
  - Hand grenades
  - Multi-Use ranges
  - Air to ground bombing/missiles
  - Ground to air missiles
  - Demolitions “blow-in-place”
  - Mines
- Weapon Systems Testing

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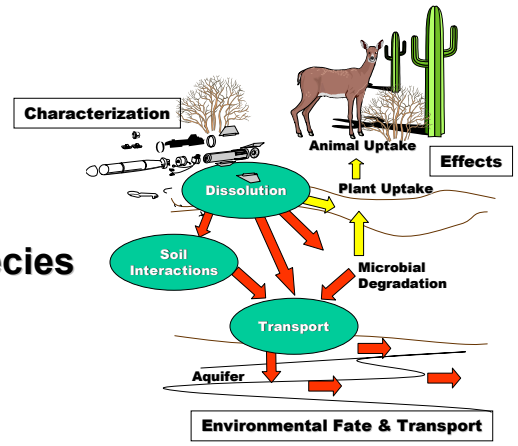
Environmental Stewardship

- Ground water
- Soil
- Ecosystems
- Threatened and endangered species
- Public health



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Characterization
Challenges

Expansive size

Extreme spatial heterogeneity

Diverse uses over time

Munitions performance low-order

Blow-in-place practices

Various climates

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Characterization
What we know

- **Distribution of explosives residues**
  - Random sampling is least effective
  - Integrated sampling approaches are needed
- **Sample handling/analysis**
  - Efficient compositing and subsampling techniques are critical
  - Chemical detection limits must be low for adequate characterization
- **Characteristics of residuals are specific to range firing activities**

Characterization
What we know

Concentrations of residues from high-order detonation are limited

Low-order detonations are significant point sources of contamination

Firing points as well as impact points can become contaminated

Characterization
What we know

Blow-in-place demolition of UXO can contribute significant contamination

Climate can exert significant effects on the character of residues

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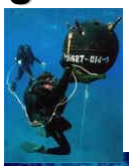
Characterization
Future Directions

Characterize air force and naval ranges




Continue characterization of residues at firing points

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Characterization
Future Directions

Refine estimates of residues from low-order detonations

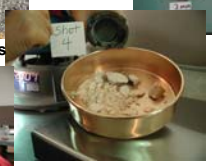

Setting up controlled low-order detonations


Low-order fragments


Residue from controlled low-order detonations


Witness plates and tarp for controlled low-order detonations


Residue analysis from controlled low-order detonations


TNT chunks from controlled low-order detonations

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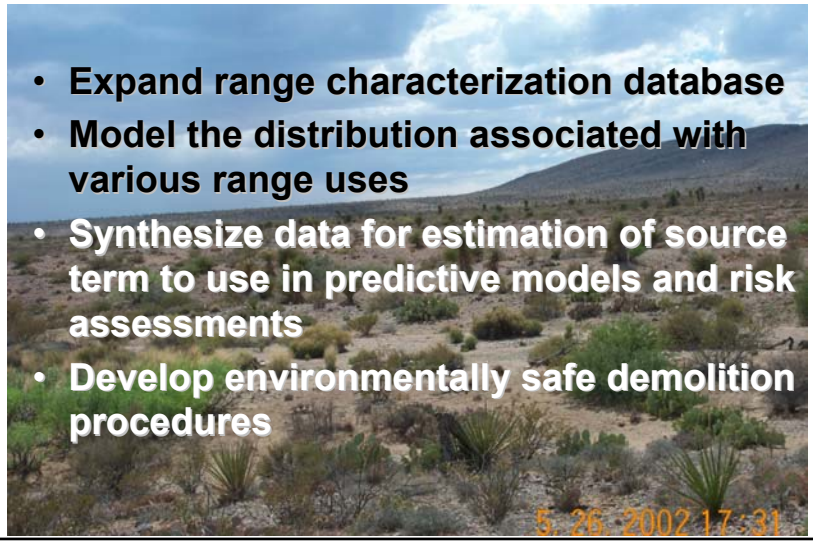
Characterization
Future Directions



- Expand range characterization database
- Model the distribution associated with various range uses
- Synthesize data for estimation of source term to use in predictive models and risk assessments
- Develop environmentally safe demolition procedures

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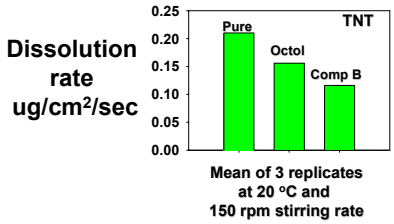
Fate and Transport
Challenges

- Corrosion rate
  - Munitions casings
  - Safety
  - Explosives residues



- Dissolution rate
  - Compositions

Octol
70% HMX, 30% TNT
Comp B
59.5 % RDX, 39.5% TNT, 1% wax

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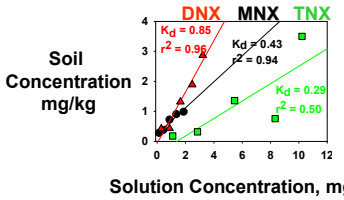
Fate and Transport
Challenges

- **Transport**
  - Various soil/climatic settings
  - Marine environments
  - Degradation products



- **Interactions with soils and marine sediments**
  - Soil adsorption and desorption
  - Transformation
  - Degradation

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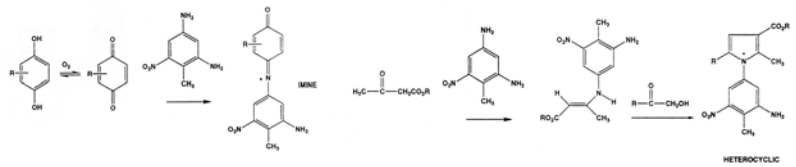
Fate and Transport
What we know

- **Soil interactions**
  - Initial release from compositions in soils tend to be locally very high, approaching temperature dependent saturation
  - Soil *adsorption* will not significantly limit transport
  - Compositions dissolve more slowly than individual components, e.g. TNT in composition B vs TNT alone
  - Transformation is slow and limited except for TNT, which transforms readily to mono amino products
  - TNT transport is limited by covalent bonding of transformation products to soils
  - Explosives residues are resistant to microbially degradation under conditions typical of ranges
  -

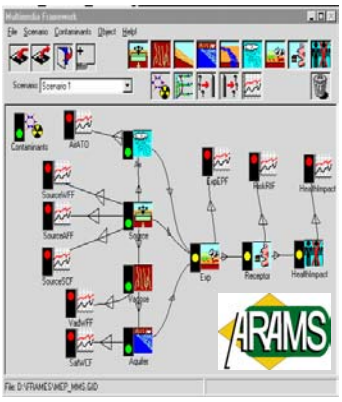


Fate and Transport
What we know

- Corrosion
  - Corrosion rates in most environments are slow
  - Casings on many high-load munitions are thick
  - Some UXOs have been in place for extended time periods
- Climate/Hydrogeology
  - TNT residues degrades via photolysis
  - RDX is the explosive of greatest concern in ground water

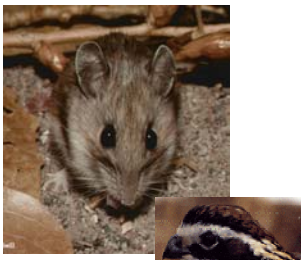
Fate and Transport
Future Challenges

- Process descriptors needed
  - Propellants
  - Smokes and obscurants
- Characterizing corrosion on bottom of UXOs
- Significance of non-HE organics
- Spatial models of the source term
- Transport models
- New generation explosives



Effects
Challenge

- Extreme ecological diversity
- Defining exposure potential for a highly distributed source
- Current database limited to a few species
- Current database includes little information on transformation products and formulations



Effects
What we know

- Toxicity varies with species (data are limited)
- Mono amino transformation products of TNT are typically more toxic than TNT
- RDX is readily bioaccumulated by plants
- TNT is rarely translocated from roots

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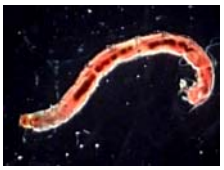
Effects
Future challenges

- Modeling exposure
- Defining representative receptor species for testing
- Filling data gaps for munitions compositions, explosives degradation products, and new generation explosives



Insect larva
Chironomus tentans

Amphipod
Hyalella azteca

Fathead minnow
Pimephales promelas

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The Good News

- The database to support development of appropriate tools for managing explosives contamination on ranges is growing.
- The potential issues are becoming better-defined.
- Some issues/concerns have been reduced.
- The relative importance of other issues are being resolved.